COMPILATION ON THE DISEASES OF NAVAL IMPORTANCE IN MICRONESIA

Including the Identification and Distribution of Arthropods of Medical Importance

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PREFACE

The purpose of this compilation is to present as thorough a summary as practicable of the available medical, entomological, and parasitological literature on Micronesia. The approach has been primarily that of preventive medicine. It is not possible in this compilation to give a completely accurate appraisal of health and sanitary conditions in these islands. This is obviously due to a lack of adequate information and to the changing conditions due to the war. However, the material compiled should provide a reasonable background of the available information. It is necessary to bear constantly in mind the fact that the material has been drawn from many sources of varying reliability. Every attempt has been made, however, to use the information as critically as possible. Attention should also be given to the dates borne by the various sources keeping in mind those conditions which are most likely to change over a period of years.

The areas included are the Caroline (including the Palau Group), Marshall, and Marianas Islands. All of these except Guam in the Marianas have been under Japanese Mandate since the first World War.

The sources of information have been primarily the reports and papers of the German physicians during the German period in Micronesia, papers and reports of Japanese physicians and entomologists, and American reports and papers from Guam. The Spanish reports have been consulted only insofar as they have been cited in the German reports. During the German period the physician in charge of each hospital submitted an annual report of the activities of his hospital or station. These reports recorded cases treated as well as the occurrence of epidemics and were published in the Arbeiten aus dem kaiserlichen Gesundheitsamte Medizinal-Berichte über die deutschen Schutzgebiete. Special notes and papers frequently appeared in the Archiv für Schiffs- und Tropenhygiene. Information on Guam is derived primarily from the Annual Reports of the Governor of Guam and papers in the U. S. Naval Medical Bulletin, as well as from other American publications. Material from Japanese sources has come from the annual reports to the League of Nations on the Mandated Islands, various official government publications such as the South Sea Islands Handbook, reports of scientific expeditions, and papers in a considerable number of professional medical and entomological publications.

Certain other publications and compilations have been made previously. Mumford and Mohr (1943) have published two very similar accounts on the diseases of the Japanese Mandated Islands and Guam. The Medical Intelligence Branch, Division of Preventive Medicine, Office of the Surgeon General, U. S. Army, has prepared restricted multigraphed reports separately on Guam, the Carolines, the Marshalls, and the Palaus. The Civil Affairs Handbook, Administrative Organization and Personnel of the Japanese Mandated Islands (OPNAV 50E-4 (Restricted)) contains information on the organization of the hospitals and medical services. Military Government Handbook, Marshall Islands, (OPNAV 50E-1) contains a large compilation of general information on the Marshalls; there is a brief section on medicine and sanitation. Similar compilations are being prepared for the Eastern Carolines, Western Carolines, and the Marianas.

Many individuals have contributed materially to the compilation of this report. Dr. Alan Stone, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, assisted in preparing the information on mosquitoes. Dr. Maurice T. James, also of the Division of Insect Identification, supplied notes on the muscoid flies of medical importance. Dr. E. A. Chapin, Curator of Insects, U. S. National Museum, arranged for laboratory space and other facilities. Dr. H. Elishewitz has supplied information on ticks. The section on poisonous fish was prepared from notes supplied by Dr. Leonard Schultze, Curator of Fishes, U. S. National Museum. The material on mammals of medical importance was prepared by Lt.(jg) D. H. Johnson, H-V(S), USNR. Captain Paul W. Wilson (MC) USN; Captain T. J. Carter (MC) USN; Captain E. G. Hakansson (MC) USN; and Lt. James W. Haviland (MC) USNR; have read the manuscript and have given valuable suggestions and criticisms. Lt. Comdr. D. F. Smiley (MC) USNR has assisted in the planning and compilation and also has critically examined the entire manuscript. Without the interest and encouragement of Vice Admiral Ross T. McIntire (MC) USN and Rear Admiral Luther Sheldon, Jr. (MC) USN, the preparation of this treatise would not have been possible.

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INTRODUCTION

Micronesia is a sprawling archipelago of more than 1,400 minute volcanic and coral islands, coral reefs, and atolls scattered over a tremendous expanse of water from 130° East Longitude to 175° East and from the equator to 22° North Latitude.

The islands lie in three major groups: the Marshalls, Carolines (including the Palau Group) and Marianas (table 1).

TABLE 1

MICRONESIA

	Number of Islands	Area in Sq. Miles
Marshall Islands	60	73
Caroline Islands (including Palaus)	549	509
Marianas Islands (including Guam	15	453
Total	624	1035

According to the estimates of the Japanese South Sea Islands Bureau 132 of these islands (including Guam) are inhabited (table 2).

TABLE 2

PRINCIPAL ISLANDS OF MICRONESIA

Island	Group	Area in Sq. Miles
Saipan	Marianas	71.4
Tinian	"	37.8
Rota	"	48.3
Guam	"	206
Yap	West Carolines	83.5
Palau proper (Babelthuap)	"	142.8
Angaur	"	1.2
Spring Island	East Carolines	8.5
Summer Island	"	3.5
Wednesday Island	"	8.9
Ponape	"	144.8
Kusaie	"	44.8
Jaluit	"	3.1

The islands are situated in the tropical zone but because of their minute size and the constant winds enjoy a relatively milder climate than other areas at these latitudes. Temperature is fairly uniform with the annual mean varying between 79° and 82° F. in the various parts of the Archipelago. The thermometer rarely rises above 86° F. and seldom falls below 68° F. Daily fluctuations rarely exceed 10° F. Although there is considerable variation from island to island, it is generally true that the northeasterly trade winds prevail between November and the following April, while between May and October the wind is predominately the southwest monsoon. However, in the Marshalls the winds during the latter period are generally east and southeast.

Micronesia lies in the area of the origin of the typhoons which frequently visit eastern Asia. Generally, the low pressure areas are poorly developed while still in Micronesia, although sometimes the storms reach intensities sufficient to cause severe damage both at sea and in the islands.

The normal annual rainfall is 60 to 135 inches. Generally, July-September can be considered as the wet season and January-March as the dry. However, there is great variation from island to island and from year to year. Rain generally comes in the form of squalls of short duration. As a rule, about one half of the daylight hours are cloudy. The mean relative humidity varies from 82 percent in the Marshalls to 87 percent in Yap.

Because of the importance of climatologic factors in the occurrence of diseases and disease vectors, a compilation of meteorologic data is given in Appendix A.

The population of Micronesia (excluding Guam) at the outbreak of the war was composed principally of Japanese and natives. Chinese and whites constituted a definite minority. The population of Guam is about 22,000 largely natives. Since 1925 there has been a rapid increase in the Japanese population in the Mandated Islands (table 3). The population data for individual islands since 1920 are given in Appendix B.

TABLE 3

POPULATION OF THE JAPANESE MANDATED ISLANDS IN 1934 ACCORDING TO ADMINISTRATIVE DISTRICTS*

District	Natives	Japanese	Foreigners	Total
Saipan	4,297	39,731	15	44,043
Yap	5,968	368	11	6,347
Palau	6,230	6,558	10	12,798
Truk	15,129	1,980	24	17,133
Ponape	8,953	2,484	30	11,467
Jaluit	9,963	485	2	10,450
Total	50,540	51,606	92	102,238

District	Male	Female	Total
Saipan	25,379	18,664	44,043
Yap	3,173	3,174	6,347
Palau	7,727	5,071	12,798
Truk	8,944	8,189	17,133
Ponape	6,416	5,051	11,467
Jaluit	5,483	4,967	10,450
Total	57,122	45,116	102,238

*Population of Guam in 1934 was 20,391.

MEDICAL SERVICES AND SANITATION

The Japanese government has maintained hospitals at Palau, Angaur, Yap, Saipan, Truk, Jaluit and Ponape. The Ponape hospital has a branch at Kusaie. Each hospital is in charge of a surgeon and the entire system is supervised by the head of the Palau hospital. In 1941 there were 24 physicians serving in the government hospital system. In addition, private firms maintained hospitals and medical service for their personnel. No detailed information is available concerning these activities. Government health activities are augmented by school physicians and by itinerant physicians who visit outlying islands. An idea of the extent of the activity of the government hospitals can be obtained from the data in the cases treated (but not necessarily hospitalized) by them as described in the South Sea Islands Handbook (1932) (table 4).

TABLE 4

TOTAL CASES TREATED AT THE SOUTH SEA ISLANDS HOSPITALS OF THE JAPANESE GOVERNMENT IN 1931

Hospital	Outpatients		Inpatients
	Cases	Treatments	
Saipan	10,876	129,220	260
Yap	3,483	22,425	---
Palau	5,571	42,374	139
Angaur	1,587	12,383	124
Truk	7,948	39,154	64
Ponape	3,205	37,531	68
Kusaie	1,034	7,108	---
Jaluit	2,224	47,767	9
Total	35,928	337,962	664

It is assumed that the medical activities were increased further since 1931. This is substantiated by the reports of the Japanese Government to the League of Nations (1937) in which the total number of cases treated is given (table 5). Details on the individual districts were not reviewed.

TABLE 5

TOTAL NUMBER OF CASES TREATED BY THE GOVERNMENT HOSPITALS IN THE JAPANESE MANDATED ISLANDS

Year	Cases
1933	37,559
1934	36,554
1935	42,065
1936	47,886

In general, sanitation is quite primitive although the Japanese have apparently made some progress in persuading the natives to use latrines and to employ better methods of garbage disposal. There has also been progress in the improvement of water supplies. On many of the islands (especially in the Marshalls) the only source of drinking water is rainwater. The Japanese have apparently had some success in bettering the sanitation of the collecting cisterns. In the Carolines and Marianas the larger islands have springs and wells as sources of water. These should not be used until properly inspected and examined. Appendix C contains the tables compiled by Arai (1928) from an inspection of all the water supply sources in the Mandated Islands. These tables indicate where water supplies exist although it is not advisable to rely on the conclusions about the potability of the various supplies. Further information on water supply is given in ONI Monographs, numbers 29, 30 and 31.

Soil pollution is still common and there is always the danger of infection with Ascaris or hookworm.

Swimming should be allowed cautiously because of the contamination of fresh water and because of venomous fish, corals, and jellyfish in sea water.

Milk supplies have always been limited although there are cattle on some of the larger islands. Dairying has never been conducted on a commercial scale and hence there has been no government inspection or regulation. All milk must be regarded as unsafe until proven otherwise. Regulations of the Japanese Government in the Mandated Islands on the sale of meat required that all animals be slaughtered in government abatoirs or by government butchers and that all handlers have a health certificate. There were also regulations governing the handling of fruit and vegetables. Meats, fruits, and vegetables, especially those handled by natives must also be regarded as unsafe unless properly inspected.

ARTHROPOD-BORNE DISEASES

Although the Micronesian Islands lie within the tropics they are unusual in that arthropod-borne diseases do not assume the importance which they ordinarily have elsewhere in the tropics. The only diseases of this group known definitely to occur in Micronesia are dengue and filariasis. Autochthonous malaria does not occur but there is a possibility that it could be established. There are no reliable records of cases of any of the rickettsioses. From a medical standpoint arthropods may well prove to be of more importance as pests than as vectors of disease.

Malaria

Malaria has apparently never been an autochthonous disease of Micronesia, a fact to be associated with the absence of anopheline mosquitoes. The two references in the literature to the occurrence of Anopheles, Satterlee (1928) and Pacific Islands Pilot (in 1928 but not 1938), are not based on actual collections and are probably erroneous.

Although numerous cases of malaria have been treated in Micronesia, especially during the German period, it is usually indicated that the disease was contracted elsewhere, frequently in Melanesia. For example Girschner (1900, 1910, 1911, 1913) on Ponape treated 18 cases in 1899, 12 in 1908-1909, 38 in 1909-1910, and 68 in 1910-1911. Born (1911) recorded 4 cases from Jaluit in 1909-1910. There are numerous such records in the Japanese and German reports. Japanese Government hospitals reported (1926-38) treating a few cases of malaria each year from 1924 to 1929 following which no records were released. Koch (1900) reported that malaria is not a disease of Ponape because he was unable to find enlarged spleens or parasites in the blood of the native children. Subsequent reports in the German literature are in agreement. The Japanese reports to the League of Nations as well as the South Sea Islands Handbook (1932) constantly emphasize that because of the absence of Anopheles there is no natural malaria in Micronesia. The few cases treated in Guam definitely have been imported.

The establishment of malaria in Micronesia is dependent, among other factors, on the successful introduction of Anopheles. This possibility is discussed by Mumford (1942) who pointed out that the larvae of Anopheles punctulatus moluccensis are adaptable to a large variety of conditions. Experience during this war has already shown that these larvae will thrive in 50 to 60 percent sea water or more. Actually the answer to the question of the possible successful establishment of anopheline mosquitoes in Micronesia is conjectural at this time. Although there are apparently suitable breeding habitats on such islands as Guam, Saipan, Yap, Ponape, and others, unforeseen climatic or ecologic factors may prevent their survival. However, it is always imperative to be cognizant of the fact that anophelines can be accidentally but successfully transported over vast expanse of waters and become established in new areas. The introduction of Anopheles gambiae Giles in Brazil (1943) is certainly adequate demonstration of this. The minimum distance between Africa and Brazil is slightly more than 1,600 miles. This was the span involved in the introduction of A. gambiae. Compare with this distances of 600 to 1,000 miles separating A.

punctulatus moluccensis (Swellengrebel and Swellengrebel de Graaf) of New Guinea and the Bismarck Archipelago from much of the Caroline Group, the distances of 1,700 miles separating A. hyrcanus sinensis Wiedemann of Japan and Formosa from the Marianas and the 400 miles between A. minimus flavirostris Ludlow of the Philippines and the Palau Group. A more remote possibility is A. sundaicus Rodenwaldt of the Malay Archipelago.

Interrogated nonprofessional Japanese prisoners of war who had been in the Marshalls (1943-1944) insisted that malaria was being contracted in the Marshalls on Kwajalein and Mili Islands. Naturally recurrences or suppressed initial attacks following the termination of suppressive quininization on leaving malarious regions may account for these statements. Nevertheless occupation personnel throughout Micronesia must be prepared to take immediate action against anopheline mosquitoes should they have been introduced during the period of the Japanese occupation. Appropriate measures should also be planned to prevent such introduction by our personnel and craft.

Filariasis

Filariasis, caused by Wuchereria bancrofti, apparently has a general distribution throughout the Micronesian Islands although its actual incidence is probably very low. Matsumoto (1935) does not regard it as an important disease of the Mandated Islands. The South Sea Islands Handbook (1926-1938) published by the Japanese Government does not even mention filariasis among the diseases of the Mandated Islands and the reports of the Japanese Government to the League of Nations do no more than to record a few scattered cases. Esaki (1939) suggests that filariasis has been introduced from the Loochoo Islands but goes further to say that no cases have been reported from Micronesia. This does not agree with the official reports from the Japanese hospitals nor with German and American reports. In 1913 von Prowazek (1913) in an extensive discussion of the diseases of the Marianas Islands did not mention filariasis except to state that it is common among the immigrants from Samoa. Because of the numerous migrations of the natives it is difficult or impossible to ascertain which cases are actually autochthonous and which are imported. Particularly important in this respect are the constant immigrations from Samoa and Loochoo.* In the Samoan area Dickson** reported a microfilaria index of 13.60 percent among the native adults of Tutuila and Belding*** (source not disclosed) cites a 27 percent index among the adult natives of Fiji. Kackley**** reported a micro-

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*Although it is not suggested in the literature, it seems logical that some cases may have been introduced from New Guinea where filariasis is endemic.
**Preliminary Report on the Prevalence of Filariasis in the Defense Force, Samoan Group. James G. Dickson, Robert W. Huntington, Jr., and Samuel Eichold. April 2, 1943. Headquarters, Defense Force, Samoan Group, unpublished.
***Textbooks of Clinical Parasitology, David L. Belding. D. Appleton Century Co., 1942. p. 360.
****Sanitary Survey of Funafuti Atoll, January 20, 1943.

filaria index of 10 percent among adult natives of Funafuti in the Gilberts. Indices as high as 60 percent have been reported elsewhere in the Gilberts. Ohama (1939,1941) and Yosino and Nakasoto (1941) have reported indices of 6 to 29 percent in the Loochoo Islands. Crow (1910) was of the opinion that the filariasis observed by him on Guam was contracted there although he thought it had been introduced previously (about 1870) from the Carolines by imported laborers. Salecker (1915) also found filariasis among the immigrants from Samoa who came to Saipan in 1910. On the other hand no microfilaria were found in the blood of Japanese prisoners taken in the Gilbert Islands. These men had previously been in the Marshalls. However, this can scarcely be regarded as negative evidence because of the relatively short time which they had spent in Micronesia and because of the long period which elapses between the time of infection and the appearance of the microfilariae in the blood.

The first definite record of filariasis in Micronesia appears to be that of Born (1908) who, in his report of 1906-1907, states that he found it on Yap, Palau, and Woleai in the West Caroline Islands. Previously cases of elephantiasis were reported by Born (1904) from Yap; Girschner (1904) from Nukuoro Island near Ponape, East Carolines; and Krämer (1908) from Truk where it was noted not to be widespread. Other reports of cases of elephantiasis during the German period in Micronesia have been recorded by Girschner (1907,1910) from Ponape; by Schnee (1911) from Saipan, Marianas Islands; Buse (1910-1911) from Yap; Mayer (1911-1912) from Ponape; Muller (1917) from Yap; and Krämer (1937) from the Lamotrek Group, East Caroline Islands (records of 1908 to 1910). Although it is not possible to know with certainty it is not unlikely that the majority of these cases of elephantiasis are due to filariasis. Crow (1910) who conducted a filariasis survey in Guam in 1910 found microfilaria only in the natives of Inarajan. The microfilaria index was about 10 percent. Kindleberger (1912) speaks of twelve cases of filariasis "up to this time" (1911) on Guam. Since 1911 the literature and reports from Guam contain no records of filariasis or elephantiasis. Born (1911-1915) stated that filariasis was found on Jaluit, Majuro, Arno, and Mili (Marshall Islands) but that it was not found on Ebon Atoll. Buse (1915) recorded the treatment of 6 cases from Angaur in the Palau Group. The Japanese reports (1926-1938) list the following number of cases of "filariasis and elephantiasis" treated in the Mandated Group; 10 in 1924, 8 in 1925 (Saipan, Angaur, Truk, Ponape, Jaluit), 9 in 1926 (Saipan, Truk, Ponape, Jaluit), 10 in 1927, 11 in 1928, 6 in 1929. In 1929 reports on filariasis were discontinued.

Whether the filariasis of Micronesia is nocturnal or nonperiodic is conjectural. In view of suggestions of Esaki (1939,1940) von Prowazek (1913), Crow (1910) and others concerning its introduction it is likely that both occur. That introduced from the Loochoo Archipelago would be the nocturnal type borne by Culex quinquefasciatus Say whereas that introduced from Samoa would be the nonperiodic type borne by Aëdes scutellaris pseudoscutellaris (Theobald), a diurnal species. Attention should be drawn to the fact that nocturnal filariasis has been reported in the Gilbert Islands which may indicate a wide distribution of this type in Micronesia.

Culex quinquefasciatus is a common mosquito throughout Micronesia. Swezey (1942) records Aëdes scutellaris pseudoscutellaris from Guam and states that in 1937 A. Cruz "reared quite a lot of them from larvae in coconut hulls at

Mogfog, Nov. 10." Apparently it is common on Guam since it constitutes a large part of the Guam Culicidae collection in the U. S. National Museum. Curiously, Esaki (1939) and Sogen (1941) in the detailed discussions based on extensive collections of the mosquitoes in the Mandated Islands do not mention Aëdes s. pseudoscutellaris. Instead they speak of Aëdes albopictus as very numerous throughout Micronesia. This species, however, has never been recorded from Guam. Considering also the fact that Esaki (1939) was not certain of his identification of "albopictus" and that albopictus and scutellaris are similar biologically and morphologically, it seems likely that the "albopictus" of Esaki and Sogen is actually scutellaris pseudoscutellaris. The Japanese use of albopictus could well spring from the confusion in nomenclature in the English and Dutch literature over the use of albopictus, variegatus, and scutellaris although this nomenclature has been clarified by Bonne-Wepster and Brug (1937).

Aëdes scutellaris pseudoscutellaris, the vector of nonperiodic filariasis, is primarily if not exclusively a daytime biter. However, attention should be given to the fact that it does not bite in open sunlight but rather in the shade. It is domestic in its habits although it has been found on uninhabited islands. Also it has been observed to bite other mammals and may possibly attack birds also. According to Bonne-Wepster (1932) it can serve as a vector of nocturnal filariasis. but rarely does so because of its diurnal biting habits. Larvae can be found in any type of accumulations of fresh water such as bottles, coconut shells, tin cans, tree holes, fallen leaves, etc. Buxton (1927) stated that they are not found in coconut shells with rotting pulp. The larvae can survive in very minute quantities of water. It is said that in coconut shells only moistness is necessary. Bonne-Wepster (1932) states that heavily infected cases of filariasis are not important epidemiologically because large numbers of larvae kill the mosquitoes. Esaki (1939) states that Aëdes, presumably aegypti and pseudoscutellaris, are very abundant on Jaluit in the Marshall Islands.

Culex quinquefasciatus also employs a large variety of breeding places. Larvae can be found in domestic collections of water, drains, flooded latrines, overflow water from kitchens, ground pools, ditches, shallow wells, and more rarely in tree holes and bamboo.

The universal rule for this species is that breeding places be in the immediate vicinity of human habitations. In general stagnating water seems to be preferred although not a necessity. This species has apparently a definite preference for human blood. Although it bites during twilight, it is more apt to bite at night. Adults are never found at any great distance from human habitations. This species was noted by Esaki (1939) to be numerous during the evenings on Kusaie, Ponape, Woleai, Palau, and Saipan and that mosquito nets are a necessity throughout the entire year.

Dengue

Dengue is the most important insect-borne disease in Micronesia. According to the South Sea Islands Handbook (1932), it "breaks out periodically and spreads rapidly to almost all of the islands." The reports of the Japanese government to the League of Nations in 1930 describe dengue as

occasionally epidemic and always endemic. As in other areas it is primarily a disease of newcomers and hence is of military importance. The suggestion of Esaki (1939) that dengue is of recent introduction from the Loochoo Islands appears to be questionable in view of the earlier German reports on the prevalence of the disease.

Many of the early German reports do not mention dengue although it appears probable that cases of dengue were diagnosed and recorded among other diseases such as grippe. Sunder (1903) reported dengue as a "new disease" on Yap. The natives of Yap, however, were not affected, the disease being confined to the natives of Palau, Woleai (south of Yap), and Sonsorol (south of Yap). Dengue was reported from Jaluit in the Marshall Islands in 1906-7 by Liesegang (1908) and in Majuro, also in the Marshalls in 1912 by Braunert (1913). Buse (1915) in his report on health conditions in Yap for 1911-1912 describes a dengue epidemic among Europeans of recent arrival. The disease, according to this account, was probably introduced from the Philippines although it is stated that dengue-like fevers occur among the natives of Yap. Kindleberger (1912) described an epidemic of dengue in Guam in 1911 which was probably introduced from the Philippines. Eighty-three enlisted men and 28 natives were admitted to the hospital. The disease has been reported sporadically from Guam since that time.

The best source of information on dengue in Micronesia is the paper of Sogen (1941). According to this author the government hospitals treated 2,844 cases of dengue (2,388 Japanese and 456 natives) in the 13 years, 1927-1939. Because of the light course of the disease among the natives it is to be assumed that many native cases did not come to the attention of the medical authorities. The statistics compiled by Sogen (1941) are given in table 6. These statistics although apparently based on government hospital reports must contain additional cases since they do not agree with the total of 2,844 cited above. The Japanese Government reported to the League of Nations an epidemic on Palau, Saipan, and Angaur in 1927 with "more than 950 cases" and "more than 2,000 cases" in 1928 on Truk, Ponape, and Jaluit as a result of the expansion of the 1927 epidemic. The 1927-1928 epidemic is also discussed by Matsumoto (1935). Earlier Japanese reports speak of epidemics in 1918 and 1920. Mashita and Homma (1923) found dengue to be a common disease on Truk in 1921. The annual reports of the governor of Guam show that this island also had epidemics in 1932 (104 cases hospitalized) and 1937 (40 cases hospitalized).

There appears to be a definite tendency towards the appearance of dengue epidemics in the five months from July to November. Sixty-six percent of the cases reported from the Japanese government hospitals have occurred during these months. Sogen has given a composite monthly occurrence of dengue in the islands for the period, 1927-1931 (table 7). Whether or not this distribution holds in the majority of years is of course conjectural. According to Sogen there is a tendency for dengue epidemics to follow periods of high rainfall. This may be correlated with the population of Aëdes aegypti which would naturally increase following a period of abundant rainfall.

As is the rule elsewhere the death rate in dengue in Micronesia is low. A single death was recorded in 700 cases treated since 1929, whereas in the Loochoo Islands where dengue is very prevalent, there was a death rate of

TABLE 6

DENGUE IN THE JAPANESE MANDATED ISLANDS, 1927 - 1939

(According to the statistics of Sogen, apparently based on government hospital records.)

		1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	Total
Saipan	J	*	124	67	13	38	69[3]	20	134	69	22	19[4]	15	23	613
	N		12	4	2		4		3	2	1		1		29
Yap	J			48		20	22	27	8	3	6	31	34	49	248
	N			13		30	119	10		2	1	5	1	1	182
Palau	J	418	11	237		24	16	13	15	6	12	93	227	62	1,134
	N	99		15					1	1					116
Angaur	J	60		8	1							4	50		123
	N	197		4								12			213
Truk	J		54						37	9	73	8	1		182
	N		84						30	1		19	15	1	150
Ponape	J		170	4		4	2			120		69	58	71	498
	N		5				1			11	1			3	21
Jaluit	J		57	9					1			22	38	37	164
	N		16	9								6	4	1	36
Total		774[1]	533[2]	418	16	116	233	70	229	224	116	288	444	248	3,709

J= Japanese cases
N= Native cases

[1]This epidemic was reported to the League of Nations as involving more than 950 cases.

[2]Reported to the League of Nations as an expansion of the epidemic of 1927 and involving more than 2,000 cases on these islands.

[3]104 cases reported from Guam.

[4]40 cases reported from Guam.

* Large epidemic reported.

TABLE 7

COMPOSITE MONTHLY OCCURRENCE OF DENGUE IN THE JAPANESE MANDATED ISLANDS, 1927-1931

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Saipan	104	27	28	15	20	20	12	13	5	5	8	3
Yap							47	35	27	2	1	1
Palau	5	1			15	118	111	26	49	282	170	50
Angaur							82	110	57	8	2	5
Truk	4	13	81	23		13			6	3		
Ponape			12	17	13	2	6	7	14	3	2	11
Jaluit							5	11	68	10	1	
Total	113	41	121	55	48	153	263	202	226	313	184	70
Percent	6.3	2.3	6.7	3.1	2.7	8.6	14.5	11.3	12.3	17.5	10.3	3.9

1.34 percent in 35,129 cases in 1931. About 75 percent of the cases which the Japanese have recorded from Micronesia were between the ages of 15 and 40 and about two-thirds were males. The majority were first infections; reinfections are rare. About 67 percent were contracted within six months after arrival in Micronesia.

Sogen assumes that the vectors are Aëdes aegypti and albopictus. However, it is very likely that only the former is involved since the "albopictus" of Sogen's data is more than likely Aëdes scutellaris pseudoscutellaris. If true albopictus does occur, it most certainly is rare since it has never been taken from Guam where several extensive collections of mosquitoes have been made.

Aëdes aegypti is an ubiquitous domestic mosquito which is never found far from dwellings. It is diurnal in its feeding habits. It breeds preferably in artificial pools of rainwater although there are records of breeding in brackish water. Larvae are found in rainwater barrels, tanks, cisterns, coconut shells, tin cans, plant leaves, etc. The period of development from egg to imago is 9 1/2 to 18 days

Aëdes aegypti is a common mosquito throughout Micronesia. According to Sogen's data about 30 percent of the adults taken on Saipan, Yap and Ponape a of this species. Apparently it is less common on Palau Islands although the observations are fragmentary. According to Esaki (1939), "the daytime attacks of the two above mentioned species (aegypti and scutellaris) are the worst nuisance in these South Sea Islands." They are especially numerous on Jaluit in the Marshall Islands. Control of aegypti in Micronesia is difficult because of the incessant rainfall which provides a constant abundance of breeding places.

Rickettsioses

There are no authentic records of any cases of rickettsioses of any

type in Micronesia. In 1912 Wendland in Hebertshoehe, New Britain, described three cases of typhus (Fleckfieber) from the Planet and the Cormoran, two German warships, which had sailed from Ponape in the East Caroline Islands. Four milder cases were not hospitalized. Wendland states that the disease was doubtless contracted at Ponape and that an investigation should be made to determine whether or not the disease occurred there. Prior to this time no cases of typhus were recorded and the German and Japanese reports subsequent to this time likewise contain no records of typhus in Ponape. In consideration of the German nomenclature during the period of German occupation of the Micronesian Islands there can be little doubt that all references except that of Wendland (1912) are to typhoid fever (Typhus, Typhus abdominalis or Unterleibstyphus) rather than to typhus (Fleckfieber). It seems very likely that the few cases of typhus reportedly recorded by the Japanese are actually typhoid fever, the German terminology being employed in the reports printed in English. This is frequent in Japanese reports and papers printed in English.

A "Marshall-typhus" has been attributed to Kwajalein Atoll, Marshall Islands, in various compilations in this country. No confirmation of such a disease can be found in either the Japanese or German literature on the Marshall Islands and the origin of the report is not apparent. It is said to be characterized by a high fever of a month's duration and a high fatality rate.

Although there are no authentic reports of typhus in Micronesia it appears wise to consider its possible occurrence or introduction. Since typhus occurs in Hawaii, the Philippine Islands, China, Japan, and New Guinea, its introduction during the movements of personnel in wartime is a possibility. Schnee (1904) in Jaluit and Fullaway (1912) in Guam, reported head lice (Pediculus humanus capitis de Geer) among the natives although body lice (Pediculus humanus corporis de Geer) have never been recorded from Micronesia. There is also in wartime the possibility of the introduction of body lice, the vectors of epidemic typhus. It appears, however, that they will not, in general, infest the natives. Rats which serve as reservoirs of endemic typhus are found throughout Micronesia. Rattus exulans, Rattus rattus alexandrinus, Rattus rattus rattus, and Rattus rattus frugivorous are common on many or all of the islands. Rattus norvegicus occurs only around the ports. Information on the occurrence of fleas is meager. According to Esaki (1939) Pulex irritans L. is extremely rare in the Japanese residences in Micronesia. Safford (1905) feels that the "absence of fleas" in Guam is due to the humid climate. Thompson's catalogue (1938) does not list Pulex from Micronesia. There is no information on Xenopsylla cheopis Rothschild, the common rat-to-man vector of endemic typhus, or on other species of rat fleas.

Matsumoto (1935) states that tsutsugamushi (scrub typhus) does not occur in Micronesia, a statement substantiated by the German and Japanese reports from the Mandated Islands and the American reports from Guam. Matsunaga (1927), Iseki (1933), and Esaki (1940) describe a species of Trombicula whose larvae causes a troublesome "red-bug" itch in Western Micronesia. Its known range, according to Esaki, extends from the Moatrok Islands on the east, westward to and including the Palau Islands. Although the larvae of Trombicula akamushi, deliensis and perhaps others are known elsewhere as vectors of scrub typhus Esaki states that the trombiculid larvae of Micronesia is not; however, his evidence is obscure.

Other Arthropod-borne Diseases

Buse and Mayer (1911) recorded three fatal cases of plague in 1910 from Yap in the West Caroline Islands. No further cases have been recorded in the literature. The South Sea Islands Handbook (1932) of the Japanese Government states that plague does not occur in Micronesia. Whether or not plague can be reintroduced is dependent to a large extent on the same conditions as those which govern to the possible reintroduction of typhus.

Von Prowazek (1913) and other German physicians referred frequently to Saipan influenza or missilepik. Von Prowazek described it as similar and possibly identical with pappataci fever and predicted that Flebotomus would ultimately be discovered. Extensive entomological collections in these islands have failed to detect the presence of any species in this genus and it appears extremely unlikely that missilepik is pappataci fever.

A single case of yellow fever has been reported from Micronesia in the Japanese reports to the League of Nations for 1930. Whether or not this case is authentic cannot be ascertained. Some Japanese physicians have used "yellow fever" as a name for infectious jaundice. Since Aëdes aegypti is very numerous, it is necessary to regard yellow fever as a disease which could be introduced and become widespread.

Tularemia, relapsing fever, leishmaniasis, and tick-borne encephalitis have not been reported and are assumed not to occur. With the exception of relapsing fever it appears that the vectors of these diseases are lacking. The situation in regard to the vectors of relapsing fever is the same as that of epidemic typhus.

Arthropods as pests are discussed elsewhere.

ENTERIC DISEASES

Enteric diseases including intestinal helminthiases are an important cause of morbidity ranking in importance lower only than respiratory diseases, tuberculosis, and venereal diseases. This can be regarded as a general reflection of unhygienic water supplies, primitive sewage disposal, contaminated soil, and the generally low plane of personal hygiene. The Japanese reports to the League of Nations (1926-1927) and the South Sea Islands Handbook (1932) emphasize that amebic dysentery, typhoid and paratyphoid fever are among the important contagious diseases. In general 10 to 15 percent of the cases hospitalized or treated at dispensaries were enteric diseases. Reports from the hospitals during the German period as well as the reports from Guam are in essential agreement although they contain no information on paratyphoid fever. Enteric diseases must be regarded as among the most important hazards to occupation personnel.

Typhoid Fever

According to Schnee (1907) typhoid fever was first recorded on Jaluit in the Marshalls in 1892. It was also reported from the Marshalls by Schnee (1904) in 1902-1903. The first report of typhoid fever in the Marianas was that of Leach (1900) who reported 18 cases in 1899 from Guam. A small epidemic was reported by Leys (1905) in 1904. Mashita and Homma (1923) reported 11 cases of "typhoid-like" fever from Saipan in 1919. These may have been paratyphoid. In general there are very few references to typhoid fever in Micronesia prior to 1920. Since that time small epidemics have been reported from Guam in 1923, 1925, 1926, 1937, 1938. The Statistical Yearbook of the Japanese Empire (1932) records statistics on the cases of typhoid fever treated in the Government hospitals for the Mandated Islands as a whole (table 7).

The available Japanese reports contain few references to specific localities. Among them however are 23 cases on Saipan (1931), 15 cases with four deaths in Truk district (1929, 1930) and scattered cases reported by the Palau, Ponape, Truk, and Jaluit Districts. It had previously been reported from Truk, Ponape, and Saipan by Mashita and Homma (1923). Two cases from Saipan and one from Yap were recorded in 1937. The logical conclusion appears to be that typhoid should be regarded as widespread but of relatively low incidence.

Paratyphoid Fever

There are no records of paratyphoid fever from the German period and the Annual Reports of the Governor of Guam contain only records of six cases of paratyphoid fever in 1924 and one case of paratyphoid B in 1932. However, the Japanese reports list considerable numbers of cases (table 8) scattered throughout the archipelago. The 11 cases of "typhoid fever-like" disease recorded by Mashita and Homma (1923) on Saipan in 1921 may have been paratyphoid. Three cases were reported from the Saipan District in 1937.

There is no information on the types involved or on any of the other salmonelloses.

TABLE 7

TYPHOID FEVER IN THE JAPANESE MANDATED ISLANDS

(Cases recorded by Government Hospitals)

Year	Cases	Deaths
1922	30	9
1923	11	2
1924	10	3
1925	4	1
1926	10	2
1927	15	4
1928	6	1
1929	40	3
1930	149	11
1931	24	3
1932	17	4
1933	21	1
1934	28	2
1935	13	2
1936	18	4
1937	3	1

TABLE 8

PARATYPHOID FEVER IN THE JAPANESE MANDATED ISLANDS

(Cases recorded by Government Hospitals)

Year	Cases	Deaths
1922	-	-
1923	2	1
1924	1	0
1925	1	0
1926	36	0
1927	4	0
1928	2	0
1929	203	1
1930	59	11
1931	11	3
1932	39	2
1933	11	1
1934	15	2
1935	31	3
1936	14	2
1937	3 (incomplete)	-

Bacillary Dysentery

Since the German reports from Micronesia do not specify the type of dysentery in their statistics, it is not possible to make a reliable statement concerning its prevalence during the German period. An outbreak on Yap and adjacent islands in 1908 was regarded by Buse (1909) as bacillary although amebae were found in the stools. The first published report of bacillary dysentery in Guam is in the Annual Report of the Governor for 1923. An epidemic of 381 cases occurred in 1925 and it is probable that the dysentery epidemic of 291 cases in 1924 was also bacillary. Ninety-three, 20 and 18 cases were reported from Guam in 1926, 1927, and 1928 respectively. Since that time only occasional cases have occurred except in 1937 when there were 86. The Japanese statistics usually do not record bacillary dysentery as such and although it has been reported from Palau, Yap, Saipan and Jaluit Districts it is not possible to ascertain whether or not the few cases reported as "dysentery" in contradistinction to amebic dysentery are bacillary dysentery or not. Mashita and Homma (1923) did not record any cases on their tour through Micronesia. According to the results of interrogation of Japanese prisoners (nonprofessional) who were captured in the Gilberts but who had been in the Marshalls, bacillary dysentery was rare among the troops there.

Amebic Dysentery

As in the case of bacillary dysentery the reports from the German period give little indication of the importance of amebic dysentery as such because the type of dysentery is not specified. Buse (1909) infers that amebic dysentery occurs in the Caroline Islands although he states that the epidemic of 1908 was bacillary. However von Prowazek (1913) emphatically states that dysentery is almost endemic in the Marianas and that he had observed personally many cases of amebic dysentery. Amebiasis was first reported from Guam by Kindleberger (1912). Since then it has been recorded more or less sporadically from Guam as has also amebic dysentery. The cases of amebic dysentery reported in the Annual Reports of the Governor of Guam in recent years show a more or less endemic condition (table 9).

The South Sea Islands Handbook (1932) considers amebic dysentery as one of the three principal diseases of Micronesia. The others are yaws and dengue. In the reports to the League of Nations the same importance is attached to amebic dysentery. Interrogation of nonprofessional Japanese prisoners indicates that amebic dysentery has been common among the troops in Micronesia. Mashita and Homma (1923) found it prevalent throughout Micronesia. The importance of amebic dysentery in Micronesia is shown by the numbers of cases listed from the Mandated Islands by the Japanese Government (table 10). Consideration must be given to the fact these figures doubtless represent only a portion of the total infections. Data from another Japanese source give figures somewhat higher for the same years. Those in table 10 are from the South Sea Islands Handbook (1932) and the Statistical Yearbook of the Japanese Empire (1920-1940). Statistics on the individual islands are not available although it appears that the disease is widespread. Eighteen Japanese and five native cases were reported from Saipan in 1919. In 1931, 35 (2) cases were reported from the Saipan District, 3 from Yap

TABLE 9

CASES OF AMEBIC AND BACILLARY DYSENTERY REPORTED FROM GUAM, 1930-1941

Year	Bacillary	Amebic	Year	Bacillary	Amebic
1930	-	15	1936	-	10
1931	-	2	1937	86	81
1932	-	33	1938	2	109
1933	-	-	1939	0	33
1934	-	18	1940	-	35
1935	-	30	1941	4	25

TABLE 10

AMEBIC DYSENTERY IN THE JAPANESE MANDATED ISLANDS

(Cases reported by the Government Hospitals)

Year	Cases	Deaths
1922	51	-
1923	84	-
1924	44	4
1925	83	10
1926	64	11
1927	146	14
1928	107	14
1929	197	27
1930	70	7
1931	254	35
1932	74	21
1933	74	8
1934	22	3
1935	33	3
1936	187	24
1937 (incomplete)	187	36

District, 140 (24) from the Palau District, 5 (1) from the Truk District, 55 (6) from the Ponape District, and 16 (2) from the Jaluit District. (Fatal cases are reported in parentheses.) In 1926 the Saipan District reported 34 cases, the Palau District 4, the Angaur District 16, Truk District 1, Ponape District 1, and Jaluit District 18. Angaur and Jaluit reported epidemics in 1925. In 1937 three Japanese cases were reported from the Saipan District, 24 Japanese and 110 (31) native cases from the Yap District, and 37 Japanese and six (3) native cases from the Palau District.

Yato (1932) has summarized his studies on amebic dysentery in the Marshall Islands where he was in charge of the Government hospital at Jaluit from 1927 to 1929. According to him amebic dysentery was introduced from Nauru by a Chinese coolie in 1907 and that the first epidemic occurred at that time. The author prefers to refer to the disease as "so-called amebic dysentery" because he was able to find amebae in only two cases. However, clinically the disease closely resembled amebic dysentery. Also he was unable to detect Shiga-Kruse bacilli in any of the cases.

According to the Japanese reports to the League of Nations liver involvement is rare. This is supported by the earlier German reports. Yato gives a tabulation (table 11) of cases treated at the Jaluit Hospital.

TABLE 11

CASES OF "SO-CALLED AMOEBIC DYSENTERY" TREATED AT JALUIT, 1922-1931

Year	Cases
1922	12
1923-4	167
1925	0
1926	18
1927	3
1928	6
1929	6
1930	1
1931 (Jan.-June)	16

In view of this author's doubt concerning his diagnosis (although reported in the official statistics as amebic dysentery) and the reports of bacillary dysentery from Guam the question arises as to whether or not the official Japanese reports of "amebic dysentery" may include some cases of bacillary dysentery. Nevertheless amebic dysentery must be regarded as one of the important diseases of Micronesia. It is also of interest to note that while the statistics in table 10 are given under "amebic dysentery" in the reports of the Japanese Government to the League of Nations they are listed only as "dysentery" in the Statistical Yearbook of the Japanese Empire.

Other Intestinal Protozoa

Kindleberger (1913) and von Prowazek (1913) record Balantidium coli

from the Marianas. Both state that it is the cause of dysentery-like diseases. Von Prowazek implies that balantidiosis is widespread and quite common in the Marianas. Salecker (1913) found 4.3 percent of the natives of Rota infected with Balantidium coli.

Kindleberger and von Prowazek have also reported Endameba coli and von Prowazek, Iodameba williamsi from the Marianas. Intestinal flagellates have been reported from Guam.

Miscellaneous Enteric Diseases

German reports from the Mandated Islands as well as the American reports from Guam indicate large numbers of cases of diarrheas, gastritis, enteritis, intestinal catarrh and other gastro-intestinal disorders. This is reflected also in the large numbers of "diseases of the digestive tract" reported in the official Japanese statistics. In general this category includes 10 to 15 percent of all cases treated at the various Branch Hospitals.

Cholera has never been reported from Micronesia. A few scattered cases of ekiri (acute infantile diarrhea) have been reported by the Japanese. Intestinal helminthiases, especially ankylostomiasis and ascariasis, are very prevalent. These are discussed in the section on helminthiases.

Of considerable importance among the enteric diseases are fish poisonings. German reports, American reports from Guam, and the official Japanese reports all list cases of fish poisoning. Poisonous fish i.e., those with toxins in various organs are common in Micronesia (see section on Poisonous Fish) and are doubtless the cause of many of these cases of fish poisoning. Many cases are also due to improper handling and preparation of otherwise harmless species.

RESPIRATORY DISEASES

From the time of the earliest Spanish and German reports to the present the respiratory diseases such as influenza, pneumonia, common colds, pharyngitis, laryngitis, bronchitis, etc., have been one of the most important causes of morbidity and mortality in Micronesia. Because of the numerous changes in diagnostic nomenclature and because of the condensed nature of the recent Japanese statistics from these islands it is not possible to compile reliable data on the incidence of the various respiratory infections. Also the available statistics are concerned principally with Japanese and natives leaving very little information applicable to whites. The high incidence in the natives can doubtlessly be attributed to the changeable humid climate, the poorly ventilated living quarters, and generally low level of personal hygiene, sanitation, and nutrition. Ratio of admissions for respiratory diseases to total hospital admissions is shown by the statistics on respiratory diseases from Japanese sources (table 12).

On Guam during the last decade from 28 to 62 percent of all cases of infectious diseases recorded have been respiratory infections (table 13).

Epidemics of respiratory diseases of such diagnoses as influenza, acute bronchitis, pneumonia, cold with fever, acute respiratory catarrh, etc., have been reported at various times in Micronesia. Prior to 1917 epidemics of "epidemic bronchial asthma" or "guha" were frequently reported from Guam at the season of the change of the winds. Since that time these epidemics have not been reported. Freeman (1907) described it as an influenza-like disease with asthmatic symptoms. Perhaps it was reported as influenza after 1918 since no cases of "bronchial asthma" appear in the reports after this date. Mashita and Homma (1923) reported bronchial asthma as abundant among the children in Saipan. Consideration should be given to the possibility that at least some of the asthma reported in Micronesia may be due to ascariasis. Asthma due to ascariasis has been noted frequently in Guam, Samoa, and the West Indies. Particularly numerous are the reports of "influenza" epidemics. Such epidemics were reported from the Marshalls in 1899 by Bartels (1900), in 1901 by Schwabe (1904), in 1908-9 by Liesegang (1910); in the Palau Islands in 1926 (Japanese reports to the League of Nations for 1926); in the Carolines in 1909-10 by Girschner (1911) and Evers (1913); in Guam in 1918 and in Saipan in 1919 by Mashita and Homma (1923). "Missillepik", apparently a febrile cold, was reported frequently from the Carolines and Marianas. For example Evers (1915) reported an epidemic in Angaur in 1911-1912 in which he treated more than 500 cases. This disease which was accompanied by a rash was also known as "Saipan-influenza". Von Prowazek's suggestion that it was pappataci fever seems untenable. However, in view of the fact that it is accompanied by a rash it is possible that it may have been dengue or a dengue-like fever. This is probably the "unknown fever" of Saipan referred to by Mashita and Homma (1923). Epidemics of acute bronchitis were reported by German physicians almost as frequently as epidemics of influenza. Mashita and Homma (1923) observed that bronchitis was common throughout Micronesia. German physicians also reported cases of pneumonia in considerable numbers although not as frequently in epidemic proportions.

TABLE 12

RESPIRATORY DISEASES IN THE JAPANESE MANDATED ISLANDS
(Cases reported by the Government Hospitals)
1924-1936*

Year	Total Hospital Admissions	Admissions for Respiratory Diseases	Percent Respiratory Admissions	NATIVES			JAPANESE			FOREIGNERS		
				Total Admissions	Admissions for Respiratory Dis.	Percent Resp. Admissions	Total Admissions	Admissions for Respiratory Dis.	Percent Resp. Admissions	Total Admissions	Admissions for Respiratory Dis.	Percent Resp. Admissions
1924	22,706	3,319	14.6	15,019	2,529	16.8	7,490	770	10.3	197	20	10.2
1925	21,650	2,984	13.8	13,847	2,035	14.8	7,676	941	12.3	107	8	7.5
1926	23,040	3,480	15.2	14,867	2,491	16.7	8,116	985	12.1	57	4	7.0
1927	30,706	4,734	15.L	19,882	3,585	19.3	10,736	1,137	10.6	88	12	13.6
1928	27,899	5,168	18.6	15,860	3,560	22.5	11,925	1,592	13.4	114	16	14.0
1929	29,276	5,179	17.6	16,970	3,305	19.5	12,170	1,849	15.2	135	25	18.6
1931	36,592	4,895	13.3	20,040	2,593	12.7	16,465	2,294	13.8	87	8	9.2

Year	Total Hospital Admissions	Admissions for Respiratory Diseases	Percent Respiratory Admissions	NATIVES			JAPANESE AND FOREIGNERS		
				Total Admissions	Admissions for Respiratory Dis.	Percent Resp. Admissions	Total Admissions	Admissions for Respiratory Dis.	Percent Resp. Admissions
1933	37,559	3,985	10.6	21,131	2,546	12.1	16,428	1,439	8.8
1934	36,554	3,684	10.1	19,145	2,282	12.0	17,409	1,402	8.1
1935	42,065	3,499	12.1	22,105	2,121	9.6	19,960	1,378	6.9
1936	47,886	4,519	9.5	23,157	2,643	11.4	24,729	1,876	7.6

*Because of a change in classification the data of 1924-1931 are not necessarily comparable with those of 1932-1936.

Note: "Admissions" include inpatients, outpatients, and clinic patients.

TABLE 13

RESPIRATORY DISEASES IN GUAM (Hospital Reports)
1931-1941

Year	Hospital* Adm.	Broncho-Pneumonia	Lobar Pneumonia	Acute Bronchitis	Acute Catarrhal Fever	Acute Tonsillitis	Total Resp. Adm.	Percent Resp. Adm.
1931	651	19	7	45	230	97	398	61
1932	1,026	23	10	43	280	77	433	42
1933	1,458**	50	5	44	124	18	241	16
1934	531	81	34	56	83	19	273	51
1935	577	58	49	61	107	6	281	50
1936	403	17	18	39	88	13	175	43
1937	624	11	22	48	76	18	175	28
1938	636	91	5	88	94	5	283	44
1939	486	31	7	26	212	6	282	44
1940	696	-	12	2	405	9	428	62
1941	1,087	13	22	-	347	23	405	51

*Contagious and infectious diseases only.

** 535 cases of measles.

Acute laryngitis and acute pharyngitis have always been reported frequently.

In conclusion it is obvious that respiratory diseases are an important cause of morbidity in Micronesia although changes and variations in diagnostic nomenclature make it difficult to specify which are most important. However, the preventive problems should differ little from those elsewhere in the tropics.

TUBERCULOSIS

Tuberculosis is very prevalent in Micronesia, a fact to be expected in a native population in a humid tropical climate. As is pointed out in the Report to the League of Nations for 1930, by the Japanese Government a very small portion of the cases of tuberculosis come to medical attention and hence hospital reports are of little value in ascertaining the incidence. The history of tuberculosis in Micronesia is obscure and it cannot be said with certainty whether or not it was introduced by whites or by one of the many Polynesian, Chinese, or Japanese migrations into Micronesia. Doubtlessly it has been reintroduced many times since its original appearance.

It seems quite certain that it first appeared in the Marshall Islands just before 1900. Bartels (1900) states that the first case, a native woman living with a white trader, was observed in 1899. Schnee (1903) observed the second case on Jaluit in 1900. However, it appears that at this time, tuberculosis was already common in the Marianas and Carolines since Leach (1900) recorded cases from Guam in 1899 and Sunder (1903) reported cases from the Carolines in 1901-2. In 1906-7 Born (1908) found it to be prevalent in Yap, Palau and Woleai. Practically all of the German reports from Micronesia and the American reports from Guam record the observations of cases of tuberculosis but there is little indication of its prevalence.

Salecker (1915) studied incidence of tuberculosis in the Marianas Islands using the von Pirquet test. Among the Chamorros 55 percent were positive. A group of 650 Caroline natives on Saipan were found to be about 30 percent infected whereas more than 70 percent of a group of immigrants from Woleai and Mogomog were positive. About 50 percent of the immigrants from Samoa were found to have positive tuberculin reactions. Satterlee (1928) listed yaws and tuberculosis as the most important diseases of Guam. Mashita and Homma (1923) found pulmonary tuberculosis to be common on Kusaie, Jaluit, Yap, and Palau. In 1929-33 Fujii (See Yanaihara, 1940) in a study concerned with the decreasing native population of Yap found that pulmonary tuberculosis was the cause of 43 percent of the deaths in 1929, 48 percent in 1930 and 1931; 22 percent in 1932, and 20 percent in 1933. It was stated that the decline in death rate due to tuberculosis does not indicate a decline in morbidity but merely the death of more severe cases. When deaths due to tuberculosis or other organs are added this investigator states that it is obvious that more than 50 percent of the deaths among the Yap natives are due to tuberculosis. Recent reports from Guam (table 14) substantiate the view that the tuberculosis morbidity among the natives is high in Micronesia.

The increase in cases probably reflects increased hospital facilities rather than a higher morbidity rate. In 1936 it was reported that the Japanese were providing special facilities for caring for tuberculosis cases.

From 1925 to 1929 the Japanese released statistics on cases treated in the Government Hospitals (table 15).

TABLE 14

TUBERCULOSIS ADMISSIONS
ON GUAM
(1932-1941)

Date	Admissions	Date	Admissions
1932	25	1937	53
1933	41	1938	34
1934	63	1939	4
1935	63	1940	65
1936	50	1941	126

TABLE 15

TUBERCULOSIS CASES TREATED IN THE GOVERNMENT HOSPITALS IN THE JAPANESE MANDATED ISLANDS

Year	Japanese	Foreigners	Natives	Total
1925	43	0	162	205
1926	39	1	171	211
1927	74	0	381	455
1928	74	3	314	391
1929	81	5	646	732
1931	66	-	333	399

VENEREAL DISEASES

Venereal diseases have been regarded as prevalent in Micronesia for many years. Practically all surveys and reports by German physicians describe them as important diseases in all of the groups of the Micronesian Islands. The reports of the Japanese government show that the situation has changed little, if any, in recent years.

In 1931, 923 cases of venereal disease (2 percent of admissions) were treated at the government hospital. Naturally, this represents a very small portion of the total morbidity. Organized prostitution is common throughout Micronesia including Guam.

Syphilis. All German reports recorded cases of syphilis. However, as Koch (1900) pointed out, the fact that yaws was confused with tertiary syphilis by the German physicians makes it difficult to ascertain its actual prevalence. Syphilis was undoubtedly introduced into Micronesia by whites, probably during the 17th or 18th Century by the Spanish. The situation in the Marshall Islands is typical of the confusion between yaws and syphilis. Steinbach (1892, 1895) states that 35-50 percent of all natives who sought medical attention were definitely syphilitic. Krulle (1904) examined 2,500 natives and states that 1.7-4.0 percent had tertiary syphilis; very few primary and secondary cases were observed. Schnee (1907) was of the opinion that there were scarcely any natives in the Marshalls in which syphilis was not at least probable. Rénész (1911) stated that syphilis was common in the Marshalls but not widespread in the Carolines. Born (1915) stated that the problem of syphilis in the Marshalls was greatly exaggerated and that there were actually very few cases. According to him, yaws was very prevalent. However, in 1913 the same author had described syphilis as "still the scourge of the Marshall Islands". Yanaihara (1940) claims, on the contrary, that yaws is rare in the Marshalls and that a very virulent form of syphilis occurs there; he cites the earlier German reports. According to Yanaihara an examination of 330 individuals in the Marshalls in 1932 revealed that 55 percent had syphilis, 40 percent gonorrhea, and 5 percent "chancre"*. Sixty-four cases of syphilis were treated at the Jaluit hospital in 1926. This author states further that yaws is prevalent in Yap, Saipan, and Palau but that no venereal disease other than gonorrhea, which is very prevalent, occurs among the natives. The official reports are contradictory, however, in recording six native cases of syphilis from Saipan in 1925 and 1926. Mashita and Homma (1923) stated that the natives of Truk were free of venereal disease although Japanese cases were observed. These authors also found no native cases of syphilis on Saipan or the Palaus. There are no statistical reports on syphilis from Guam in recent years. In conclusion it seems best to assume that syphilis is widespread in Micronesia but that in many areas (such as in the Carolines and Marianas) it is much less common than yaws, and primarily a disease of the Japanese.

Gonorrhea. Gonorrhea was probably introduced by the Spaniards in the 17th or 18th Century. During the German period it was reported from most of the inhabited islands. According to the Japanese reports it is the most common venereal disease in Micronesia. Yanaihara (1940) cites the results of a survey in 1932. On Yap, of 2,354 examined, 33 percent were found to be in-

*Probably chancroid.

fected with gonorrhea; no cases of syphilis or "chancre" were observed. Forty percent of the Marshall Islanders were found to be infected with gonorrhea in 1932. On Ponape gonorrhea is very prevalent and regarded by the natives as inevitable; 48 percent of the children were found to be infected in 1924. Blennorrhea conjunctivitis was found to be very prevalent on Saipan in 1921 by Mashita and Homma (1923). Gonorrhea is said to be common among the natives of Guam although statistics for recent years are not available. Data on the treatment of gonorrhea for 1925 and 1926 in the Government hospitals are available (table 16).

TABLE 16

CASES OF GONORRHEA TREATED IN JAPANESE GOVERNMENT HOSPITAL (1925-1926)

	1925		1926	
	Japanese	Natives	Japanese	Natives
Saipan	62	3	76	1
Yap	2	1	-	-
Palau	75	2	55	3
Angaur	9	-	13	3
Truk	16	26	15	34
Ponape	11	6	7	10
Jaluit	16	138	47	157

Naturally these cases represent a minute protion of the total morbidity.

Chancroid or soft chancre has been reported sporadically (Marshalls, Saipan, Yap, Palau, Angaur, and Ponape) although the actual numbers of cases are very small. Yanaihara (1940) stated that in 1932 five percent of the inhabitants of the Marshall Islands were found to have "chancre". It is possible that this report is referring to chancroid. Thirty cases of climatic bubo (venereal lymphogranuloma?) were reported by Rife (1902) from Kusaie in the Carolines. In 1906 cases were also observed on Truk and Ponape. Granuloma inguinale may have been introduced among the Japanese troops.

YAWS

Yaws has obviously occurred in Micronesia for many years. It has occurred in Guam for at least 130 years, perhaps much longer. It is widespread in all of the islands at the present time although it appears that the Japanese have reduced its incidence considerably in recent years. It is not possible to obtain reliable information concerning its prevalence during the German period because, according to Koch (1900), it was so frequently confused with tertiary syphilis. Hamlin (1939), for instance, suggests that Braunert's description (1913) of syphilis among the natives of the Marshall Islands was probably based on observation of yaws. However, many of the German reports from all parts of Micronesia record diagnosis and treatment of cases of yaws.

The Japanese reports (1926) revealed that over 80 percent of all cases of tropical disease admitted to the Government hospitals give a history of yaws. In 1935 the report to the League of Nations stated that yaws was widespread but that acute cases were rare. From 1926 through 1929 the Japanese released statistics on the treatment of yaws in the government hospitals.

The South Sea Islands Handbook (1932) gives data for 1926, 1927, 1928, 1929 and 1931 (table 17).

TABLE 17

YAWS IN THE JAPANESE MANDATED ISLANDS

(Reports of cases treated at Japanese Government Hospitals)

Year	Japanese	Foreigners	Natives	Total
1926	15	0	2,363	2,378
1927	55	0	3,200	3,255
1928	46	0	2,325	2,371
1929	39	2	2,262	2,303
1931	35	0	2,490	2,525

About seven percent of all cases handled by the Government Hospitals are for treatment of yaws. Actually the data compiled in table 17 represent only a small portion of the total numbers of cases since the natives are reticent about seeking medical aid. Yanaihara (1940) states that a survey (1932) showed that almost all of the adult natives of Saipan, Yap and Palau had yaws. The prevalence of yaws in Micronesia is also illustrated by statistics from Guam (table 18) where until 1914 it was described as the most prevalent disease.

Up to this time it was variously estimated that 70 to 90 percent of the population were infected.

TABLE 18

YAWS IN GUAM (HOSPITAL RECORDS)
1932-1941

Year	Cases	Year	Cases
1932	30	1937	25
1933	26	1938	5
1934	43	1939	8
1935	23	1940	-
1936	33	1941	20

Gangosa, generally regarded as an acute manifestation of yaws, in which there is destructive ulceration beginning in the soft palate and extending to the hard palate, larynx and nasal cavity*, is common in Guam where it has probably occurred for at least three centuries. It was first brought to attention by the report of a Spanish commission in 1828. According to von Prowazek (1913) it is also common on Saipan, Guam, Jaluit, Ulithi, and Yap. It was common in Guam at the time of the American occupation since it is obvious that the large amount of tertiary syphilis described by Ward (1899) doubtless refers to gangosa.

McCullough and Amgeny (1909) stated that in 1907 and 1908 gangosa was one of the most important diseases of Guam. It was estimated that there were 250 cases in 1908. In 1918, 369 cases were under observation. Porter (1932) states that in 1931 68 cases of yaws were treated, 300 were under observation and that there were also 298 cases of gangosa under observation. Japanese reports (1923-1929) list a few cases of gangosa from the Mandated Islands as a whole.

Yaws must be considered as an important and widespread disease in Micronesia. However, based on previous experience, it should not be a problem among Naval personnel.

*Some investigators have regarded gangosa as a tertiary syphilitic lesion.

SKIN DISEASES

Skin diseases are extremely prevalent among the natives of Micronesia. This prevalence is not surprising in considering the unhygienic habits of the natives and the high relative humidity and high mean temperatures. Almost without exception the German physicians in Micronesia (1900-1915) emphasized the high incidence of the various skin infections. Japanese sources such as the South Sea Islands Handbook (1932) and the Reports to the League of Nations (1926-1937) are in agreement with the German reports. From 1930-1937 about 10 percent of all cases treated at the Government Hospitals were various skin infections. Medical reports in the Annual Reports of the Governor of Guam contain very few data on skin diseases. Ito and Yamanouti (1940) have published statistics concerning the cases of skin diseases treated among the Japanese in the Marianas and Carolines (table 19).

TABLE 19

PREVALENCE OF THE IMPORTANT SKIN DISEASES IN MICRONESIA, 1937-1939 (Hospital Records)

Hospital	Eczema	Urticaria	Impetigo	Furunculosis	Tricho-phytosis	Pom-pholyx
Palau	659	35	315	620	292	109
Saipan	316	22	20	182	118	89
Chiaranka	211	31	60	158	20	45
Total (Japanese)	1,186	88	395	960	430	243
Total (Natives)	141	0	110	117	35	15

Fungus Diseases. Tinea imbricata or ringworm was reported as common in the Marshalls by Bartels (1900) and Schwabe (1905); in the Carolines by Sunder (1903), Buse (1909, 1911), Born (1908), Schnee (1909); and in the Marianas by Schnee (1911) and von Prowazek (1913). In the Annual Report to the League of Nations for 1930 by the Japanese Government it is stated that 20 percent of all cases admitted to the Government Hospitals had tinea imbricata. Ito and Yamanouti (1940) in an extensive discussion of the skin diseases of the Mandated Islands state that the various dermatophytoses are extremely prevalent. Matsumoto (1935) lists tinea imbricata and tinea versicolor as the important skin diseases of the Mandated Islands. Iseki (1935) states that 28 percent of 1,131 persons examined in Micronesia were infected with tinea versicolor. It was observed to be most prevalent in the 20-40 year age group. Japanese reports include considerable numbers of cases diagnosed as trichophytosis, tinea capitis, tinea glabroso, tinea imbricata, and tinea versicolor have been reported from Guam. The inhabitants of the Mandated Islands, according to Matsumoto (1935), are also afflicted with a peculiar symmetrical acrodepigmentation of the hands and feet which is known as safu on Truk and karo on Saipan and in the Palau Islands. Matsunaga (1928), although he was able to find the typical filaments of tinea albigena in cases of this disease, considers it primarily a hereditary disease. Four cases of Madura foot were treated by Sunder (1903) on Yap.

Eczema. According to Ito and Yamanouti (1940) eczema is widespread in Micronesia although considerably less common than in Japan proper. Of 915 primary school cases of skin diseases examined by these authors in Saipan and Palau only 22 had eczema. However, at the hospitals in Palau and Saipan more cases (Japanese) of eczema were treated than any other skin disease (table 19). There are reports of cases of eczema from most of Micronesia during the German period. Particular note should be made of the condition referred to by the German physicians (such as Born, 1915) as Marshall eczema or dregga. It is described by Born as a mixture of skin sores, wounds caused by scratching, effect of salt water, and secondary infections, usually localized on the lower legs but sometimes spreading over the entire body.

Furunculosis. Boils are very common among both the natives and the Japanese. Among the skin diseases only the number of cases of eczema exceeds the number of furunculosis cases treated in the hospital. Apparently this situation has changed very little since the time of the German occupation.

Impetigo. According to Ito and Yamanouti (1940) impetigo is fairly prevalent in Micronesia. It has been described as one of the most common diseases of Guam. There are no records of it in the reports of the German physicians which probably indicates a difference in diagnostic nomenclature.

Skin diseases caused by arthropods. Iseki (1933), Esaki (1939) and Matsumoto (1935) have described a "red-bug itch" caused by hexapod mite larvae probably of the genus Trombicula. Esaki (1939) is particularly emphatic in describing it as a scourge of visitors to the Palau Islands. It seems that this mite is confined to the Western Carolines and the Palaus. (See section on mites and ticks.) Matsunaga (1926) describes still another mite which produces a dermatitis. Esaki (1939) suggests this is Pediculoides ventricosus Newport and describes the dermatitis as copra itch. Scabies has been reported by Schnee (1909) from Ponape, Liesegang (1909) from Jaluit, and (1913) from Ponape (176 cases), and Evers (1913) from Angaur and Palau. It has also been reported from Guam. Ito and Yamanouti have reported it from school children in the Marianas and Palaus. A vesicular dermatitis caused by nocturnal cantharidin-producing beetles has been described by Matsunaga (1924) and Esaki (1939). The dermatitis is caused by contact with the insect. (See section on beetles of medical importance.) Centipede, scorpion, and midge bites are common.

Other Skin Diseases. Leprosy is, in general, rare. Acute and chronic ulcers, especially on the legs, are common. There have been many admissions on Guam for "abscesses"; erysipelas and "cellulitis" have also been reported frequently. Pemphigus, erythrasma, and molluscum contagiosum have also been reported. Rashes due to discharged jellyfish nematocysts are also encountered.

HELMINTHIASES (Except Filariasis)

Helminthiases are prevalent in Micronesia especially in the Marianas. The most important types are ascariasis and ankylostomiasis. The prevalence of these is to be associated with the extensive pollution of soil and water supplies and unhygienic habits of the natives. In general, Europeans and Americans have been found to become infected readily and within a short time after arrival. Japanese reports in 1931 revealed that one-seventh of all outpatients were treated for parasitic infections.

Ankylostomiasis. Many of the reports of the German physicians record cases of helminthiasis but these give little indication as to actual prevalence of the hookworm parasites. Both Necator americanus and Ancylostoma duodenale occur although the latter is more common. Mayer (1912) made more than 700 stool examinations on Saipan, and found 66 percent infected with hookworm. On Guam Kindleberger (1913) found 78 percent of the native stools with hookworm. Soil samples from all parts of the island contained larvae. Von Prowazek (1913) stated that ankylostomiasis was prevalent on Saipan and Rota. Reed (1924) found that among white children who had been in Guam more than six months 21 percent were infected with hookworm; 5 percent of white adults who had been there more than six months were infected. Natives were found to be 31 percent infected. Salecker (1915) estimated that almost 100 percent of natives of Saipan had ankylostomiasis. The same rate was observed among immigrants from the Carolines. The same author (1913) found 83 percent of the inhabitants of Rota infected. Mayer (1915) states that ankylostomiasis was not observed in Saipan until 1914.

Matsunaga (1927) made fecal examinations of 855 inhabitants of the Truk Islands. Among those groups where feces were deposited in the sea the rate was about 30 percent whereas among the natives who defecated into the brush the rate was about 55 percent. Infection in the Moatrok Islands was found to be 8.8 percent. Porter (1932) was of the impression that ankylostomiasis was increasing on Guam. The Japanese reports in the Mandated Islands for 1926 and 1927 list cases of ankylostomiasis from all of the groups, although more cases were treated in the Marianas than elsewhere.

Ascariasis. Ascariasis has been reported throughout Micronesia. It was reported as early as 1899 by Bartels (1900) in the Marshall Islands and by Leach (1900) in Guam. Leys (1905) describes ascariasis as very prevalent on Guam and that no person, native or white, who had been on Guam more than six months was without these worms. Mayer (1912) found everyone except five whites examined by him on Saipan to be infected with Ascaris lumbricoides. Kindleberger (1913) found 92 percent of all native stools on Guam to contain ascarid eggs. A similar prevalence was recorded from Rota by Salecker (1913). Reed (1924), in investigations on Guam, found that 69 percent white children and 7 percent white adults who had been on Guam more than six months were infected with Ascaris. Natives were found to be 94 percent infected. Eggs were found in soil samples throughout the island. Matsunaga's data (1927) indicate an infection of 85 to 95 percent among the inhabitants of Truk and about 70 percent among the inhabitants of the Moatrok Islands. It is important to note that the incidence was not lower among those natives who dis-

pose of their feces in sea water. This is correlated with observations in Samoa which indicate that Ascaris eggs can mature in sea water as well as in fresh water.

In 1926 and 1927 cases of ascariasis were reported from all hospitals in the Japanese Mandated Islands with the largest numbers from the Marianas and the Carolines.

Other parasitic nematodes. The whipworm, Trichuris trichiura, occurs throughout Micronesia. Reed (1924) found 67 percent of the natives of Guam infected; von Prowazek (1913) described it as common in Saipan and Rota; Matsunaga (1927) found 50-80 percent of the natives of the Truk and Moatrok Islands infected. It has also been recorded in the Marshall Islands. Oxyuris vermicularis has been reported from the Marshall Islands, Guam, Saipan, Rota, and the Carolines.

Cestoda. Tapeworm infections have been recorded at various times. Generally they have been among Europeans and must be assumed to have been contracted elsewhere. Taenia saginata was reported from the Marshalls by Schwabe (1905) but he did not state whether it was from a white or native. The Japanese reported a native case in 1926. It appears best to assume that autochthonous taeniasis does not occur in Micronesia.

Trematoda. It has been assumed that autochthonous trematode infections do not occur in Micronesia since the cases reported can usually be accounted for by infection elsewhere. However, in the Japanese reports there are native cases of lung fluke infections. Six were reported from Ponape in 1925, and 18 in 1926. Single cases were reported in 1925 from Palau and Jaluit. These are also possibly imported cases although the nearest known endemic areas are the Philippines.

MISCELLANEOUS INFECTIOUS DISEASES

Infectious eye diseases. Various infectious eye diseases have been reported from Micronesia especially by the German physicians. As early as 1892 Steinbach (1893) observed an epidemic of a contagious conjunctivitis in the Marshall Islands (Jaluit, Raliket, Ailinglap, and Kwajalein). Girschner (1907) treated 87 cases of conjunctivitis (presumably contagious) on Saipan in 1904-5. Apparently this infection was common in the Marianas for Schnee (1910) stated that he treated 62 cases of "purulent conjunctivitis" and reported (1911) the treatment of 255 cases of infectious conjunctivitis for 1909-10. Mayer (1912) stated that "purulent conjunctivitis" was the most important disease on Saipan in 1911.

Leber and von Prowazek (1911) observed three eye diseases on Saipan: (1) "Epitheliosis disquamativa conjunctivae, caused by Lyozoon atrophicans"; (2) an acute bacterial conjunctivitis caused by an organism similar to the Koch-Weeks bacillus introduced into the Marianas by either the Mortlocks or immigrants from Samoa, and (3) papillary hypertrophy associated with a chlamydozoan virus of some type.

There are few records of "eye diseases" from Guam. In 1923 fifteen cases of trachoma were recorded and three of them were sent back to Saipan. Forty-one cases of acute conjunctivitis were reported in 1940 and 231 cases in 1941.

Braunert (1913, 1915) described acute conjunctivitis as one of the principal infectious diseases of the Marshall Islands. Buse and Mayer (1913) observed an epidemic (130 cases treated) on Yap which was thought to have been introduced from Saipan. Trachoma has apparently been introduced during the period of the Japanese Mandate. Mashita and Homma (1923) recorded 170 cases (14 Japanese and 156 natives) on Saipan in 1921. The Japanese reported cases treated in 1925 and 1926 in the Government Hospitals (table 20).

TABLE 20

CASES OF TRACHOMA REPORTED BY THE GOVERNMENT HOSPITALS

	1926		1927	
	Japanese	Natives	Japanese	Natives
Saipan	136	176	153	172
Yap	-	-	-	-
Palau	4	19	11	7
Angaur	6	4	3	5
Truk	-	-	-	-
Ponape	-	7	2	2
Jaluit	-	11	3	27

The South Sea Islands Handbook (1932) states that 1,288 cases of trachoma (926 Japanese, 362 Natives) were treated in 1931 in the entire Mandate. This was 3.5 percent of all cases treated by the Government Hospitals.

Smallpox. The history of smallpox in Micronesia is obscure. Apparently, it was first introduced in Ponape in 1853; this introduction was followed by a severe epidemic in 1854. McCullough (1908) stated that smallpox was introduced to Guam in 1856, the same year that it was first brought to Saipan (von Prowazek, 1913). Vaccinations were made as early as 1852 in the Carolines and it is said that during the 1856 epidemic on Guam, which caused 5,000 deaths, the governor without medical assistance or advice, vaccinated many of the natives. During the German period, vaccinations were made in considerable numbers and somewhat systematically. The same was true on Guam when it was begun in 1902. Apparently the Japanese started a systematic vaccination program in 1922. The South Sea Islands Handbook (1931) states that the program is the same as in Japan. No cases of smallpox have been definitely reported since 1900 although the Japanese Government reported a suspected case in 1926 and another in 1930.

Measles. Epidemics have been recorded throughout Micronesia. Although this disease was unusually severe among the natives when first introduced, this no longer seems to be the case. Chickenpox also has been reported throughout Micronesia. Epidemics of whooping cough and mumps have been reported since the time of the American occupation of Guam and the German occupation of the other islands. Some of the whooping cough epidemics have been accompanie by high case fatality rates. Scarlet fever and diphtheria, although reported less frequently, apparently occur sporadically throughout Micronesia. The Statistical Yearbook of the Japanese Empire records 15 cases of diphtheria from 1934 to 1937. In 1937 there were five cases of diphtheria (four fatal) in the Saipan District. Grunwell (1905) described an epidemic of acute anterior poliomyelitis on Guam in 1899. There were 70 deaths. Japanese reports list cases for 1926 and 1927 although the islands involved are not given. Tetanus apparently occurs sporadically throughout Micronesia. Cerebrospinal meningitis has been reported by Japanese (273 cases from Saipan, 107 from Angaur, and 9 from Ponape in 1926). Three cases reported by Japanese in 1937 (islands unspecified) are the last records. Two cases occurred on Guam in 1927 and 10 in 1931. The Japanese reported 2 native cases of anthrax in 1930. Liesegang (1910) described four cases of a febrile disease observed by him in 1908-9 which he diagnosed as Malta fever. In 1929 the Japanese reports recorded two cases of leptospiral jaundice. In connection with this it is interesting to consider the description of Schnee (1907) concerning an epidemic of catarrhal icterus which occurred in the Marshall Islands during July and August, 1900. Mashita and Homma (1923) reported an epidemic of jaundice described as possibly Weil's disease on Kusaie.

FAUNA OF MEDICAL IMPORTANCE

As is true of most oceanic islands Micronesia is poor in numbers of species of animals. Many of the species have probably been introduced relatively recently by man. Many are hardy cosmopolitan or cosmotropical species whereas others are widespread Austro-Pacific species. The Marianas show a definite Oriental and Palearctic influence whereas the Palau group has certain Austro-Melanesian species. The remainder of the Carolines and the Marshalls show a definite Polynesian influence.

Mosquitoes (Culicidae)

Authorities are in general agreement that Anopheles does not occur in Micronesia. Schnee (1912), Leys (1905), Fullaway (1912), Swezey (1942), Sogen (1941), and Esaki (1939) as well as the reports of the Japanese government to the League of Nations (1926-1934) all state specifically that Anopheles is not found in Micronesia. These statements are based upon actual collections of mosquitoes. The two reports of Anopheles in Micronesia (Guam) by Satterlee (1928) and the Pacific Islands Pilot (1928, but not 1938) seem in both cases to be unfounded. Apparently neither are based on actual collection specimens. Nevertheless there is, particularly in wartime, the constant possibility of the introduction of anopheline mosquitoes into Micronesia. Whether or not any species thus introduced could become established is conjectural. The sensible attitude appears to be to take all possible precautions against introduction particularly by aircraft and to be constantly alert so that their presence can be detected promptly and followed immediately with the proper control measures. Because of the importance of immediate detection of Anopheles this genus is included in the accompanying keys to the Culicidae of Micronesia. The most likely malaria vectors from the standpoint of introduction appear to be A. punctulatus (ssp. punctulatus or moluccensis) from Melanesia, A. hyrcanus from Chosen or Japan, or A. minimus from the Philippines. Many of the larger islands appear to have suitable breeding places for these species.

Fullaway (1912), Swezey (1942), Sogen (1941), and Esaki (1939,1940) are all in agreement that Aëdes mosquitoes are very numerous. The plagues of mosquitoes described in the early German report were doubtless due to Aëdes. There is apparently some confusion in the Japanese literature on the identity of the mosquitoes of this Genus in Micronesia. Both Sogen (1941) and Esaki (1939, 1940) describe Aëdes albopictus as an abundant species although Esaki (1939, 1940) indicates that the identification is not entirely certain. The collection of Swezey (1942) from Guam has considerable numbers of Aëdes scutellaris pseudoscutellaris but no specimens whatsoever of albopictus as reported throughout Micronesia including the neighboring island of Saipan by Esaki and Sogen. Considering the Guam collections, the admitted doubt of Esaki's determination, the fact that scutellaris and albopictus have been confused in the English and Dutch literature, and the biological and morphological similarity of albopictus and pseudoscutellaris it seems quite logical to assume that the "albopictus" of Esaki (1939, 1940) and Sogen (1941) is in reality pseudoscutellaris. Nevertheless the possible occurrence of albopictus must always be borne in mind until definitely proven otherwise.

The daytime attacks of the Aëdes mosquitoes are described by Esaki (1939) as the worst nuisance in Micronesia. This is especially true in Jaluit

which is an atoll rising only one meter above sea level and having practically no fresh water. Here the larvae are found in the various cisterns, tanks, barrels, etc., which are used to collect rain water for drinking purposes.

Aëdes aegypti (L.). Because of its importance as a vector of yellow fever in other parts of the world, more is known about the habits and life cycle of this species than of any other mosquito. It is an ubiquitous domestic species whose range includes all of the tropical and subtropical regions of the world. In summer it may even extend into temperate regions where it will breed until frosts come. It has been reported throughout Micronesia (Japanese Mandated Islands) in the early German reports, such as Schnee (1912), and by Esaki (1939) and Sogen (1941). It has been reported from Guam by Bragg (in Dyar and Knab, 1917), Fullaway (1912), Schwezey (1942), and Yamada (1932). The adults fly by day and are fierce biters. They attack quietly although a fine high note can be recognized at the time of biting. They seem to prefer to attack from behind or beneath and will frequently crawl into clothing in order to bite. Larvae can be found in many types of habitats, preferably in artificial pools of rainwater although there are records of breeding in brackish water. Larvae are found in rainwater barrels, tanks, cisterns, coconut shells, tin cans, plant axils, etc. The period of development from egg to imago is 9-1/2 to 18 days.

Aëdes scutellaris pseudoscutellaris (Theobald). This subspecies appears to have expanded into Micronesia from Fiji and Samoa where it is very common. Assuming that the "albopictus" of Esaki (1939) and Sogen (1941) is pseudoscutellaris this form can be said with certainty to have a wide distribution in Micronesia. It has been reported from Guam by Cruz (1937) and Swezey (1942). It is an abundant species in the collection of Culicidae from Guam at the United States National Museum. Swezey (1942) states that the Stegomyia scutellaris reported by Fullaway (1912) was actually Aëdes pandani and not scutellaris pseudoscutellaris. A. s. pseudoscutellaris is a daytime biter although it attacks in the shade rather than in open sunlight. It is domestic in its habits although records from uninhabited islands show that it is not necessarily so. Furthermore, it has been observed to bite other mammals and may possibly attack birds also. Eggs are deposited and larvae can be found in any type of accumulation of fresh water such as bottles, coconut shells, tin cans, tree holes, fallen leaves, etc. Buxton (1927) stated that they were not found in coconut shells with rotting pulp. However, Cruz (1937) found larvae in coconut shells on Guam. The larvae of pseudoscutellaris can survive in amazingly minute quantities of water. Actually moistness alone seems to be sufficient.

Aëdes albopictus Skuse. This is an oriental species which has been introduced into the Hawaiian Islands. As explained in a previous paragraph, the albopictus reported by Japanese investigators is probably pseudoscutellaris. However, the occurrence of true albopictus is a definite possibility and for that reason it is included in the accompanying keys. Aëdes albopictus is morphologically and biologically similar to scutellaris. It breeds in all types of artificial collections of water and not uncommonly in the water in plant axils. Larvae are rarely found in puddles and other accumulations of water on the ground. The adult females are anthropophilic diurnal domestic species. They are not as domestic as aegypti however since they come into houses only to bite. Because of its domestic habits and its hardy characteristics this species is easily transported and established in new areas.

Aëdes pandani Stone. This species was collected in great numbers in Guam by Swezey in 1936 and Oakley in 1937-8. According to Swezey (1942) it is the species which Fullaway (1912) described as Stegomyia scutellaris noting that it was very abundant in the forests and referred to as Stegomyia scutellaris. Swezey (1942) describes this species as very troublesome during the day whenever one was in the gardens, ranches, or forests. The effect of the bite of this species, however, is not as severe as that of other members of the genus. Larvae are found only in the water in the axils of Pandanus of which there are several abundant species on Guam. Larvae and adults of Aëdes pandani were found everywhere on the islands. This species has not been recorded elsewhere in Micronesia. It is possible, of course, that it may constitute a part of the pestiferous Aëdes mosquitoes described in the German and Japanese literature.

Aëdes oakleyi Stone. The larvae of this species were collected from a water barrel and reared by Oakley. There is no information on the habits or abundance of the adults.

In addition to the Aëdes species listed in the above paragraphs Esaki (1939) speaks of an Aëdes sp. close to "albopictus" (scutellaris?) whose larvae were found in great numbers in water in the leaves of pitcher plants (Nepenthes) which are abundant on Korea and Babelthuap (main island of Palau) in the Palau Group. No descriptions are given so that it is impossible to know what species the author had encountered. It is not unlikely that it may be a hitherto undescribed species. It is very possible that other undescribed Aëdes species may be encountered in Micronesia.

Only a single species of Culex has been definitely recorded from Micro - nesia. However, it is more than likely that at least one more species occurs on some of the islands.

Culex quinquefasciatus Say (=fatigans). Esaki (1939, 1940) reports this as a numerous nocturnal mosquito on Kusaie, Ponape, Woleai, Palau, and Saipan. He states that, although the numbers are not excessive, it is necessary nevertheless to wear nets throughout the year on these islands. It is also described as common on Guam by Swezey (1942) who regards it as the "Culex sp. near vishnui" recorded by Fullaway (1912). It is probably also the Culex sp. of Schnee (1912) from Saipan. The biology of this species is well known. It is domestic in its imaginal and larval habits. Larvae can be found in domestic collections of water, drains, flooded latrines, overflow water from kitchens, ground pools, ditches, shallow wells, and more infrequently in tree holes and bamboo. The prime requisite is that the habitats be near human dwellings. Stagnant water is preferred although by no means necessary. The adults are anthropophilic and nocturnal in their feeding habits although they bite to a lesser degree in twilight. They are never found far from human dwellings.

In addition to C. quinquefasciatus Swezey (1942) speaks of an undetermined Culex species. The small dark mosquitoes mentioned by Esaki (1939) from Japuteick Island in Ponape harbor may be a Culex. This species is described as producing a very painful sting.

*Keys To The Mosquitoes Of Micronesia

The keys have been prepared from material in the U. S. National Museum and include all species recorded in the literature. Aëdes albopictus is included although it is not certain whether or not this species occurs in Micronesia. Specimens from Hawaii were used although no larvae were available. The genus Anopheles is included because of its possible introduction.

Adult Females

1. Palpi in both sexes almost as long as proboscis; abdomen never entirely covered with scales, often nearly bare; scutellum crescent shaped with evenly distributed marginal setae----------genus Anopheles (None of this genus has been reported from the area, but it is inserted because of the importance of immediate detection should it be found. Introduction under the conditions of rapid transportation of the present war must be considered as imminent.)

-- Palpi of female much shorter than proboscis; abdomen densely clothed with scales, both above and below; scutellum trilobed, the marginal setae in three groups----------2

2. Tarsal segments uniformly brownish, not distinctly banded; proboscis without a distinct narrow white band at middle----------3

-- Tarsal segments distinctly banded or otherwise marked with white; if these bands are narrow, the proboscis dark with a white band------4

3. Scutellum densely covered with flat yellowish-white scales; tip of abdomen sharply pointed----------Aëdes (Aëdimorphus) oakleyi Stone

-- Scutellum with narrow curved scales only; tip of abdomen bluntly rounded----------Culex (C.) quinquefasciatus Say (=fatigans Wied.)

4. Proboscis dark, with a median white band; top of head without a sharply defined spot of pale scales----------Culex (C.) annulirostris Skuse

-- Proboscis uniformly dark; top of head with a sharply defined patch of pale scales----------5

5. Dorsum of thorax with four stripes, the median pair slender, yellowish straight, the lateral pair broad anteriorly, silvery, curved, clypeus with white scales----------Aëdes (Stegomyia) aegypti (L.)

-- Dorsum of thorax with only a single median stripe, with or without lateral stripes; clypeus without scales----------6

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*Prepared with the assistance of Dr. Alan Stone, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

6. Dorsum of thorax with only a median white or creamy yellow stripe on a dark background ----------7

-- Dorsum of thorax with three narrow yellow stripes on a yellowish-brown background only the median stripe reaching anterior margin, the lateral stripes short curved----------Aëdes (Stegomyia) pandani Stone

7. White scales on pleura of thorax arranged more or less in two lines; a line of white or creamy scales over wing-root continuing nearly to lateral lobe of scutellum; pale abdominal spots slightly removed from bases of segments----------
--------Aëdes (Stegomyia) scutellaris pseudoscutellaris (Theobald)

-- White scales on pleura of thorax arranged in irregular patches; a patch of white scales in front of wing-root only; pale abdominal spota at bases of segments----------Aëdes (Stegomyia) albopictus Skuse

Fourth Instar Larvae*

1. No distinct air tube ---------- genus Anopheles

-- A distinct air tube, somewhat longer than basal width----------2

2. Air tube with several pairs of hair tufts----------3

-- Air tube with but a single pair of hair tufts----------4

3. Air tube about four times as long as width at base, tapering from about the middle; four pairs of hair tufts on air tube, the subapical one out of line ----------Culex (C.) quinquefasciatus Say (=fatigans)

-- Air tube about six times as long as width at base, tapering evenly from base; about six pairs of hair tufts on air tube, none markedly out of line ---------- Culex (C.) annulirostris Skuse

4. Comb scales with pronounced denticles at base; thornlike process at base of metathoracic hair tuft large, strong----------
----------Aëdes (Stegomyia) aegypti (L.)

-- Comb scales without basal lateral denticles, but usually finely fringed; thornlike process at base of metathoracic hair tuft small, inconspicuous----------5

5. Length of antenna about 6 times its greatest width, antennal hair about at middle---Aëdes (Stegomyia) scutellaris pseudoscutellaris (Theobald)

-- Length of antennal shaft about 10 times its greatest width; antennal hair slightly beyond middle---------Aëdes (Stegomyia) albopictus Skuse
This last couplet is based upon published statements, and has not been checked against specimens of albopictus. Because of their similarity, care should be exercised in the determination of albopictus and scutellaris pseudoscutellaris.

*The larvae of Aëdes oakleyi and A. pandani, both from Guam, have not been described.

Other Diptera

About 30 species of Ceratopogonidae, biting midges, have been recorded from Micronesia. The geographical distribution of these is given by Tokunaga (1940). Only a few attack man and only two species are present in sufficient numbers to present a medical problem.

Culicoides peliliouensis Tokunaga. This midge is very abundant in the Palau group and is known as the Palau gnat. According to Esaki (1939) they are very troublesome to everyone. There is a periodicity in their appearance. Esaki (1939) states that they appear for about a week around the first and middle of the month and disappear almost completely between these periods. During the periods of abundance these midges appear daily at 1500-1600 and then gradually decrease after dark and disappear almost completely by midnight. He believes that the bimonthly periodicity is in some way controlled by the tides. C. peliliouensis breeds in the mangrove swamps. It is a small insect, 1.0 to 1.4 mm. in length, but its sting inflicts a sharp pain. The site of the bite swells with violent itching which may prevent the victim from sleeping. A susceptible person may suffer for several days. The natives and resident Japanese are said to have developed a certain degree of immunity. These insects are sufficiently small so as to enable them to pass through ordinary mosquito netting readily. However, they can be driven away with smudges. This species has been recorded from several of the islands of the Palau group but none of the other Micronesian Islands. Another species is supposed, according to Esaki (1939), to exist on Palau but no further information is available.

Culicoides esakii Tokunaga. This species occurs principally in the mountains of Ponape although it has been recorded elsewhere in the Carolines. The larvae are found in mountain streams. On Ponape it is recorded by Esaki as extremely abundant. It is a smaller species (less than 1.0 mm.) than peliliouensis and not as severe a biter. Therefore in spite of its tremendous numbers it is not as important as a pest.

Flies are common throughout Micronesia although little is known about the species involved. Stomoxys calcitrans (L.), the biting stable fly, has been recorded from Guam. The house fly of Guam and perhaps the rest of Micronesia is either Musca domestica (L.) or Musca vicina Macquardt. M. sorbens Wiedemann may also occur in Micronesia although there are no records. Blow flies (Calliphora sp.) have been recorded from Guam as has also Sarcophaga misera Walker. It is possible that these genera occur on many of the islands although information is completely lacking. Other flies of medical importance which occur on Guam are Lucilia graphita Shannon and Ophyra chalcogaster Wiedemann both of which have habits similar to Musca as well as Chrysomya megacephala (Fabricius) and C. rufifacies Macquardt. No papers on the muscoid flies collected by the Esaki Micronesian Entomological Expedition (1936-1938) have been found.

Chironomid (Chironomus, Tanypus, etc.) midges are common but are harmless. Simulium and Flebotomus do not occur in Micronesia.

Lice and Fleas

Information on fleas is almost completely lacking. Esaki (1939) states that they may be fairly widely distributed among the natives but that he was unable to obtain any specimens. According to this author Pulex irritans (L.) is extremely rare in the Mandated Islands and almost impossible to find in the Japanese residences. In his later paper (1940) he states that "it is believed that they (fleas) do not breed in Micronesia because of the humidity." This suggestion concerning humidity apparently comes from Sanford (1905). Rats are common but the occurrence of Xenopsylla cheopis Rothschild is purely conjectural. This point should be given immediate attention by entomologists. Thompson (1938) did not list Pulex and Xenopsylla in Micronesia.

Schnee (1904) recorded Pediculus humanus capitis de Geer and Phthiris pubis from Jaluit in the Marshalls. Girschner (1904) describes lice as abundant among the natives of the Truk Islands. The same author also (1910) reported cases of head-louse infestation from Ponape. Fullaway (1912) found the same species in Guam. There are no reports whatsoever to indicate the presence among the natives of Micronesia of the body louse. Esaki (1939) apparently collected no specimens of lice and merely says that head and pubic lice have been reported from Micronesia.

Cockroaches and Bedbugs

Bedbugs have been reported from most of the larger islands in Micronesia. The species is the tropical bedbug, Cimex hemipterus Fabricius. The early report of Cimex lectularius L. by Fullaway (1912) may be a misidentification although it is possible that this species may be introduced into port cities where it might survive for considerable periods. Bedbugs are said to be common in native quarters, but as would be supposed, they are rarely found in the dwellings of Japanese, Americans, and other foreigners. The problem for Naval personnel should be no different from elsewhere.

There has been very little information published on the cockroaches of Micronesia. Fullaway (1912) observed that Blattidae are numerous on Guam and according to the records of the Hawaiian Sugar Planters Association (1943) the common roach, Periplaneta americana, is very abundant. These records indicate that five other species are also present. Doubtless americana and others are to be found elsewhere in Micronesia. However, they should not present any unusual problems.

Beetles of Medical Importance

Several species of beetles, commonly known as "lamp bugs", belonging to the Oedemeridae are known to occur in Micronesia. The medical importance of these species in the Mandated Islands has been discussed by Esaki (1939). These insects produce cantharidin which is present in the secretions and the body fluid. This substance is a severe irritant to the human skin and contact with it causes inflammation and blisters. These beetles according to Esaki (1939,1940) are extremely numerous in Micronesia. He lists the following species with their known Micronesian ranges:

Eobia truckana Kōno---------- Truk
E. uchiyamai Kōno---------- Palau Group
E. gigantea Kōno----------Ponape
Alloxacis flavipes Kono----------Saipan
Sessinia decolor Fairmaire-------Marshalls
S. impressithorax Pic.----------Marshalls
S. livida Fabricius---------- Marshalls
Anaca palmarus Zacher---------- Marshalls

Some of these records are based on the material collected by Karsch (1881). Two species of Anaca are recorded by Schnee (1904) from the Marshall Islands but the specific names (identified by Kolbe) are not given. Blair (1940) records Sessinia canella from Truk and four species of Copidita from the Carolines. It is not known whether or not Copidita spp. are of any importance as cantharidin producers. The "lamp bugs" are slender, delicate beetles, colored brilliant yellow to dark brown according to the species. Size also varies according to species from 8-9 mm. and 12-15 mm. These beetles are positively phototropic and gather in great numbers around lights at night. They often fly into dwellings in great numbers thus affording the chance of contact with human skin. Esaki (1939) states that at times hundreds of these insects will fly into rooms and surround the lamps in thick clouds. Matsunaga (1938) has described the vesicular dermatitis caused by contact with these beetles. The symptoms are similar to those caused by Paedurus.

The following is also given by Esaki (1939): "The insects are known to be damaging to coconuts, gathering in the male flowers and damaging them. When they gather honey by boring through the perianth thousands of them may be seen covering the coconut flowers. Since the coconut honey is known as toddy, the beetles (lamp bugs) are also called the toddy beetles. Toddy is a delicacy liked by the natives who brew the wine by fermentation. In some islands under Japanese mandate the gathering of this honey is prohibited because of the intoxicant made from it. In Wotje of the Marshall Group the author witnessed the beetles gathering in hordes around a honey gathering establishment. When the beetles drop into the honey, it is no longer fit to drink. Therefore, great caution is taken to prevent the beetles from getting into the collecting bottles. In Woleai the wine is customarily prepared by putting the honey into a coconut husk and storing it in front of the house. If one has a grudge against the person brewing the wine, he may put the beetles secretly into the coconut husk and thus cause those who drink it later great suffering."

Wasps and Ants

Stinging wasps are sufficiently abundant in Micronesia to cause Esaki (1939, 1940) to include them in his report on the insects of medical importance. The genera Megachile and Pison are widely distributed throughout Micronesia. Lithurgas also has a fairly wide distribution. Also in the Marianas and Palau Groups there are several members of Sumenidae. All of these groups contain stinging species. The important group in this respect, however, is the Vespidae which are especially numerous in the Marianas. The vespid wasps of Micronesia have been discussed by Esaki (1939) and Swezey (1942). Polister olivaceus de Geer is a large yellow-legged wasp which is very common around dwellings. The

drones which are driven from the nest and enter the dwellings are harmless. Ropalinda marginata sundaica (van der Wecht), another vespid wasp, is a small long-legged species. It is also common throughout the Marianas. As in the previous species nests are built beneath leaves or in trees. Stinging wasps in general constitute a problem no different than elsewhere although they may be somewhat more numerous.

Ants are important in Micronesia from the standpoint of destruction of stored food, etc., as well as in attacking man. At least five species fall into the first category but the problem is no different from elsewhere and further discussion is omitted. Odontomachus haematoda is widely distributed and very abundant in Micronesia. It is a large black ant with conspicuously long jaws. The bite of this species is very painful. The females are winged. The workers are apt to crawl into the clothing when one walks through the brush or forest. Specimens have been collected from all of the larger Micronesian Islands. They are described as pests by Schnee (1904), Fullaway (1912), Wheeler (1912), and Esaki (1939,1940). Solenopsis germinata rufa Jerdon is the small red species known as the fire ant and is extremely abundant in the Marianas (including Guam). Its bite is more painful than would be expected from a small insect. They frequently invade dwellings and gather in the beds. It is a very troublesome pest. Camponatus variegatus novahollandiae Fabricius, known, according to Esaki (1940), as the South Seas giant red ant, is a large yellowish-brown red ant living mostly on trees. The bite is not as severe as that of Odontomachus, except for the soldier caste which have large heads and whose bites are very painful. Esaki (1941) describes them as numerous in Kusaie and Ponape.

Mites and Ticks

The information on ticks is scanty and probably unreliable. Whatever species do exist are certainly of relatively recent introduction. A large species, reported by Esaki (1939) as probably Rhipicephalus sanguineus Latreille, is common, although it certainly attacks humans infrequently, if at all. Fullaway (1912) reported Margaropus annulatus australis from Guam. This species was doubtless introduced with cattle.

Small red hexapod trombiculid larvae (Trombicula sp.) are abundant on all of the islands in western and southern Micronesia. They are the cause of the "red-bug" itch and are described by Esaki (1939) as the scourge of all visitors to these islands. The range of this species, whose identity remains to be established, is from the Moatrok group on the east to the Palau group on the west. The dermatitis caused by these larvae is well known to the natives who call it "shin" in Truk and "krasus" in Palau. Iseki (1933) describes the dermatitis and its relation to these larvae. This author as well as Matsunaga (1926) described the mite as Leptus. However, it seems that the larvae must belong to Trombicula or a closely related genus. Matsunaga (1926) also believed that different species were involved on Palau and Truk. Esaki (1939) does not agree.

These larvae are abundant in the sandy soils of the atolls particularly in the coconut and Pandanus thickets and are most numerous after a squall. The larvae are hexapod with red bodies less than 0.2 mm. long making them difficult to detect without magnification. They seem to congregate on the lower

half of the body, especially on those parts covered by clothes such as the feet (within the shoes), lower legs (in the socks), genitals, and groin.

Esaki (1939) states that, if the larvae are discovered within "a few hours" of the time of attachment and removed, no ill-effect will be experienced. If not, itching will begin in "3-5" hours and a small papule will appear. If this papule is left without scratching or treated to relieve the itching it will disappear within a few days. However, the itching is so intense that usually the papules are scratched. This often results in the formation of a blister and eventually an ulcer which will take about two weeks to cure. After it has healed there is usually a marked pigmentation which may persist for several months. Esaki (1939) states that the larvae do not transmit scrub typhus (tsutsugamushi). Exposed parts of the body, strangely, are never attacked.

Matsunaga (1926) also mentions another mite which according to him causes an itching dermatitis. He referred it to the genus Tyroglyphus. However, Esaki (1939) thinks that it may be Pediculoides ventricosus Newport and that the dermatitis is "copra-itch".

Itch mite, Sarcoptes scabei has been reported by Schnee (1909) from Ponape, by Liesegang (1910) from Jaluit, and Evers (1913) from Palau and Angaur. Liesegang (1913) recorded 176 cases of scabies from Ponape.

Scorpions and Spiders

Scorpions are common throughout Micronesia. Isometrus europaeus (=I. maculatus de Geer). This species is said by Esaki (1939) to be rather uncommon although it frequently gets into kitchens and pantries where it is a menace to humans. Its sting is extremely painful, although never fatal. It is known to occur on Jaluit, Kusaie, Koror, Palau, Saipan, Truk, and Ponape. Hormurus australasiae Fabricius is also widely distributed in Micronesia. It is never found indoors but rather is common on coconut trees. Its sting is not as poisonous as that of I. europaeus. It has been found on Saipan, Rota, Ponape, Truk, and the Palau group.

There are no poisonous spiders in Micronesia.

Centipedes and Millipedes

There are at least ten species of centipedes known to occur in Micronesia. These have been described by Esaki (1939, 1940) and Attems (1914, 1938). Two genera, Scolopendra and Otostigmus, are represented. However, only species of the former are known to be of medical importance. Scolopendra morsitans L. apparently is spread throughout all of the islands. They are especially abundant in the Marianas. They live outdoors under logs and leaves as well as in damp places in dwellings. Generally they are less than 10 cm. in length although sometimes they are longer. S. subspinipes Leach is a larger species attaining a length of 18 cm. in the Marianas. Esaki (1939) believes that it also has a general distribution in Micronesia. This species often invades houses. Their bite is extremely painful and it is well to avoid being bitten by them. Centipede bites

are frequent in Micronesia. The German reports indicate that the treatment of centipede bites was a common item in the medical service extended to the natives and other inhabitants. Esaki (1939) indicates that the same is true under the Japanese occupation.

The large myriopods (Spiroboloidea) apparently are confined to the Palau group. They are especially abundant on Peliliou and Angaur. They are extremely numerous in rotting wood and on trees. When caught or trapped, they exude a dark brown liquid which can be squirted laterally as much as 20 cm. and in quantities sufficient to moisten the whole surface of the palm. There is at least one known case of temporary blindness (three days duration) due to the discharge of this fluid into the eyes. If the fluid strikes the skin, it causes a sloughing of the epidermis within a few days.

Rodents

The rodents of Micronesia have been introduced without exception at one time or other by man. Information on the distribution and abundance of the known species is fragmentary and considerable variation in the actual numbers will doubtless be encountered from island to island.

There are four species that are best distinguished from one another by body size and the relative length of the tail. Color cannot be depended upon to distinguish the species. To determine the relative length of the tail, bend it sharply forward along the back and see whether or not it reaches beyond the nose.

Length of head and body about 75 mm. (3 inches)----------
----------House mouse (Mus musculus)
Length of head and body about 125 mm. (5 inches)----------
----------Polynesian rat (Rattus exulans)
Length of head and body 150 mm. (6 inches) or more
Tail longer than head and body----------
----------Common house rat (Rattus rattus)
Tail shorter than head and body----------
----------Norway rat (Rattus norvegicus)

House mice (Mus musculus) occur wherever there are villages and have undoubtedly spread out into the fields on the larger islands. They have little if any medical importance. There are definite records from the islands of Saipan and Guam in the Marianas; Yap, Lamotrek, and Ponape in the Carolines; and Jaluit in the Marshalls.

Polynesian rats (Rattus exulans) were present in the islands when white men first arrived, having been brought in centuries before by the natives. They have been reduced in numbers and perhaps exterminated in some places by the larger and more aggressive rats introduced by the white men. Consequently the Polynesian rats are most likely to be found now on the small, remote islands. Sometimes they are exceedingly abundant about the houses of the natives. They can apparently survive on small atolls that are washed over during storms. Nests are sometimes built in coconut trees at the bases of the fronds. The natives try to kill off the rats when they become too abundant, and sometimes use them for food. The color may be light or dark brown, but it is seldom or never black. A subspecies (micronesiensis) has been named from Ponape, but it is not known to differ in habits from the other Polynesian rats. There are definite records from the islands of Saipan and Agijuan in the Marianas; Koror in the Palaus; Yap, Woleai, and Truk in the Carolines; Jaluit and Odia in the Marshall Group.

Common house rats (Rattus rattus) are to be expected wherever ships have called regularly. In the larger and more settled islands they have killed off or driven out the small Polynesian rats, and from an economic and medical point of view they are the most troublesome mammals that will be encountered. Generally in tropical countries they are more abundant than Norway rats. Three types that are usually designated as subspecies may be distinguished on the basis of color, as follows: R. r. rattus is entirely black; it is usually

found in and about human habitations. R. r. alexandrinus is grayish brown above and gray below; it is also found chiefly about settlements. R. r. frugivorus is brown above and white below; it tends to live away from buildings and is largely aboreal, nesting in the fronds of coconut trees. The gray-bellied alexandrinus is usually the most common. There are definite records of one or more subspecies of Rattus rattus from the islands of Saipan, Tinian, Rota, and Guam in the Marianas; Koror and Babelthuap in the Palaus; Yap, Ulithi, Truk, Ponape, and Kusaie in the Carolines; and Jaluit and Majuro in the Marshalls.

Norway rats (Rattus norvegicus) are likely to be found in this area chiefly about wharves and warehouses and under the floors of dwellings. They do very little climbing, preferring to live in burrows in the ground or in ready-made cavities, such as sewer drains and the crevices in loose-rock fills and breakwaters. Black Norway rats, which are rather rare, are sometimes regarded as a subspecies, R. r. hibernicus. There are definite records of Norway rats from the islands of Saipan and Guam in the Marianas; Koror in the Palaus; and Truk and Ponape in the Carolines; and Jaluit in the Marshalls.

As yet there is no evidence to indicate that the rats of Micronesia are reservoirs of any of the diseases which affect humans. The single exception is a small epidemic (3 cases) of plague reported in the Marianas in 1910-1911. However, consideration should be given to their potential roles in plague, typhus, and leptospiroses.

Other Mammals

There are no other mammals on Micronesia of medical importance. Bats are numerous and are actually the only native mammals. In general, there are two types of bats, the large fruit-eating species and the small insectivorous species. The former are referred to frequently as flying foxes and are of economic importance because of their attacks on such fruits as the guava and breadfruit. They can be recognized at considerable distance by their slow laborious flight. The natives are said to kill these bats both to prevent damage to their crops and as a source of food. Deer have been imported into the Marianas Islands including Guam but are not known to be present elsewhere in Micronesia. They are destructive to gardens and plantations and are a source of food to the natives. Among the domestic animals pigs, cattle, water buffalo, horses, mules, goats, sheep, dogs, and cats have been introduced. On some of the islands pigs, dogs, and cats now have become wild.

Reptiles

There are no poisonous terrestrial reptiles in Micronesia. At least three lizards are known to occur but all are harmless. In the ocean about the islands are several species of sea snakes (Hydridae). These snakes are easily identifiable by their laterally compressed tails. All are poisonous although some are much more so than others. However, they do not strike unless forcibly restrained such as in removing them from fish nets. They do not attack bathers. If sea snakes are avoided, snake bite poisonings are not apt to occur.

Poisonous Fish*

The problem of poisonous fish in Micronesia is actually no different from that in other tropical areas bordering the Pacific and Indian Oceans. However, it is enhanced by the close contact with the ocean and the almost complete absence of a fresh-water fauna. Fish poisonings were commonly reported by the German physicians and there have been numerous cases recorded in the Japanese and American reports. Schnee (1903) in the Marshalls apparently made the first observations on poisonous fish in Micronesia. In 1911 he described a number of cases of Synaceia-poisoning from various islands of Micronesia. A Japanese report from the Marshalls indicates that the government hospital treats about a dozen cases of fish poisoning each year. Case fatality is placed at 10 percent. Mashita and Homma (1923) observed that fish poisoning was a source of trouble both to the natives and to the Japanese particularly in the Marshalls and Marianas. Fish poisoning occurs by the eating of poisonous flesh or viscera or by being punctured by venomous spines or barbules.

All fishes with poisonous flesh belong to the Plectognothi. These fish lack the ordinary scales characteristic of bass, trout, etc. Instead they are covered with bristles or spiney scales, strong sharp thorns, or spines, or encased in a bony box-like covering. Some are naked i.e., with no scales or spines. In this group are the fish** commonly referred to as swell or puffer fishes, porcupines, burr fishes, cow fishes, trunk fishes, box fishes, thorn fishes, etc. These are primarily species of coral reefs and rarely occur in the open sea. The poison in the flesh of the puffers and porcupine fishes is an alkaloid and is therefore not destroyed by cooking. It is commonly experienced that those in breeding condition are most poisonous. There is much disagreement among the natives as to which species are poisonous. It is possible that in many cases poisoning has been due to toxins produced by bacterial action due to improper handling and preparation.

Venomous fish (fish with poisonous spines) are also common in Micronesia. The most important species belong to the scorpion family** (Scorpaenidae) are commonly known as scorpion fish; warty lump fishes or spiny toad fishes (Synanceia); zebra or tiger fishes; or stinging fishes.

The next most dangerous venomous fishes are the sting rays. These occur in shallow water, lagoons, estuaries, etc. They usually lie on the bottom

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*Much of the information in this section is from notes supplied by Dr. Leonard P. Schultz, Curator of Fishes, U. S. National Museum.

**There are illustrations of these fish in "Survival on Land and Sea," Publications Branch, Office of Naval Intelligence, 1943.

concealed in the mud or sand where it is very easy to step on them. When this occurs, the tail whips upward driving its spine into the leg of the victim. There are records of these spines actually being driven into the bones of the feet or the legs. Some catfish have pectoral fin spines equipped with poison glands. The poison produced is not particularly toxic but there is danger of secondary infection in the wound produced by the spines.

If it is desirable to collect and preserve specimens for identification, the following points should be observed. If possible, the fish should be placed alive in a mixture of one part of commercial formalin and nine parts of water. This solution is of sufficient strength to preserve small fish up to five inches in length, in about three days, but larger specimens should be left in it for a greater length of time, depending on their size. All specimens over three inches in length should have a small slit made in the side of their abdomen, or they should be injected with the formalin preservative. Very large fish, a foot or more in length, should have the formalin not only injected into their abdomen, but about every two inches in the muscle tissue as well, and left in the formalin solution from five to seven days, or more. After that time, if it is desired, they can be transferred to water, and the formalin washed out for one or two days, and then placed in seventy-five per cent alcohol. One precaution should be observed, never to crowd the fish in the containers. There should be plenty of excess space and they should never be placed in the container like sardines are packed in a can. If it is desired to leave the specimens in formalin indefinitely, they may be transferred to a weaker solution, made up as follows: One part formalin to fifteen or eighteen parts of water, to which has been added two teaspoonsful of borax to each gallon of preservative. This weaker formalin solution is usually of sufficient strength to preserve the fish indefinitely if the container is closed tightly. Always fill the containers full of liquid.

If formalin is unavailable alcohol can be used. Specimens should be placed, while still alive if possible, into thirty-five per cent alcohol and in about six hours they should be placed in seventy five per cent alcohol. If the specimens are at all crowded, the alcohol should be poured off and fresh seventy-five per cent alcohol added the next day. If specimens become soft, then another change of alcohol should be made, using seventy-five per cent again. In general, formalin preservation is best at the start and should be used instead of alcoholic preservation because the formalin hardens the specimens. However, after the fish have been in formalin a week, they should be transferred to seventy-five per cent alcohol, after thoroughly washing the formalin out, because the acid in the formalin has a tendency to soften the bones unless it is neutralized.

Labels with essential data (date, locality, kind of water, collector) should be placed in each jar package. A durable paper (linen) should be used when the label is placed in the preserving fluid. If for security reasons, data cannot be included it should be given a number and the same number placed with the specimens. Fish, after they are thoroughly preserved (usually 1-2 weeks), may be wrapped for shipment in the following manner: Place the small fish in a stack (like wood is piled), with their heads outward, so that the tails are protected, and then wrap them in cloth, with the ends secured firmly, tied up with a string, or sewed. Be sure and protect all the fins when wrapping fish for shipment. All containers should be completely filled with packages of fish, or the excess space filled with excelsior, or dry grass. Do not use paper; it softens and dissolves in

the liquid and does not fill the spaces. After the container is completely filled, then most or all of the excess liquid may be poured off, leaving the contents of the container wet. Be sure the container is sealed to prevent evaporation. In the case of metal cans, the top should be soldered on. Shipment may be made by mail or express or other means.

In the event formalin or alcohol is not available, fishes may be preserved in salt. The fish should first be soaked in a saturated brine solution and, when thoroughly impregnated, they should then be packed in dry salt for shipment. As in the case of other methods of preservation, the abdominal cavities should be opened to allow the salt solution to enter freely. It may be necessary in the case of fishes that feed on vegetation, to open the intestinal tract and remove the vegetable matter accumulated therein.

To secure identification the specimens should be sent to the U. S. Naval Medical Center, Bethesda, Maryland, Attention, Curator of Fishes, U. S. National Museum. Because of the confusion in nomenclature and the lack of information on the distribution of poisonous species, any collections of fish suspected of being poisonous would constitute an important contribution to the knowledge of this subject.

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APPENDIX A
METEOROLOGICAL DATA ON THE JAPANESE MANDATED ISLANDS

The following tabulations are taken from Sogen's (1941) treatise on dengue in Micronesia. These records were taken from the data of the government meteorological stations. The Japanese Government has apparently not allowed the publication of reports given exclusively to meteorologic observation.

TABLE I

METEOROLOGICAL OBSERVATIONS ON JALUIT

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature ° F.	Daylight hours with sunshine %	Rainfall Annual Total mm.	(inches)	Wind Velocity	Fair Days	Days With Rain
1927	758.2	85	82.4	---	3769.2	(148)	---	---	206
1928	758.5	81	82.4	---	4343.1	(170)	---	---	264
1929	757.3	82	82.2	---	3705.6	(146)	1.1	---	302
1930	758.5	82	82.9	---	3501.3	(138)	1.6	---	267
1931	758.5	79	83.3	---	2929.0	(115)	1.4	---	256
1932	758.0	94	81.9	---	4973.3	(196)	---	---	317
1933	758.1	83	81.3	---	4236.5	(166)	2.3	---	314
1934	758.1	81	82.0	---	4119.5	(162)	1.9	---	300
1935	757.8	81		---	4751.8	(187)	2.2	---	312
1936	757.8	80	82.0	---	3530.7	(139)	2.6	---	---
1937	756.9	81	81.7	---	4432.5	(175)	4.3	2	287
1938	756.8	82	81.3	55	3277.8	(129)	2.7	---	288
1939	756.8	81	81.5	56	3154.2	(124)	3.2	---	274
AVERAGE	757.8	82		56	3901.9	(154)	2.3	1	282

TABLE II

METEOROLOGICAL OBSERVATIONS ON THE PALAU ISLANDS

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature °F.	Daylight hours with sunshine %	Rainfall Annual Total mm.	(inches)	Wind velocity	Fair Days	Days With Rain
1927	757.1	81	80.6	49	4378.4	(172)	2.1	3	290
1928	757.0	82	80.8	50	4031.2	(159)	2.4	---	278
1929	757.0	82	80.4	51	4783.2	(188)	2.4	---	292
1930	757.6	82	80.1	51	3383.1	(133)	2.4	3	259
1931	757.5	81	80.6	54	3497.9	(138)	2.0	1	288
1932	757.1	83	80.2	51	4656.0	(183)	1.9	1	287
1933	757.0	81	80.2	51	3498.3	(138)	1.8	3	271
1934	756.9	82	80.4	52	4059.3	(160)	2.2	---	293
1935	756.9	81	80.4	58	3428.3	(135)	2.2	2	273
1936	757.2	80	80.4	58	4061.0	(160)	2.3	---	269
1937	757.1	80	80.6	58	3828.2	(151)	2.1	---	275
1938	756.8	81	80.6	57	3270.5	(129)	2.2	---	295
1939	757.0	81	80.4	57	3972.5	(156)	2.3	2	268
AVERAGE	757.1	81	80.4	54	3911.4	(154)	2.2	1	278

TABLE III

METEOROLOGICAL OBSERVATIONS ON PONAPE

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature °F.	Daylight hours with sunshine %	Rainfall Annual Total mm.	(inches)	Wind Velocity	Fair Days	Days With Rain
1927	757.4	81	79.9	---	3959.4	(156)	1.5	---	---
1928	756.6	83	79.3	46	5883.5	(232)	2.4	3	280
1929	756.8	83	79.3	47	5430.0	(214)	2.6	1	319
1930	757.1	83	79.3	45	4759.2	(187)	2.5	9	296
1931	757.4	81	79.9	50	3523.6	(138)	2.8	---	290
1932	757.0	83	79.3	42	4801.4	(189)	2.6	1	322
1933	757.2	82	79.2	44	5050.6	(199)	2.6	1	318
1934	757.2	81	79.5	48	4396.5	(173)	2.4	3	312
1935	756.9	83	79.5	42	5147.9	(203)	2.1	1	325
1936	757.1	82	79.5	43	4802.1	(189)	2.2	3	310
1937	757.1	82	79.5	41	4604.8	(181)	2.2	---	320
1938	756.9	83	79.2	40	5677.1	(224)	2.2	1	323
1939	756.9	82	79.7	45	4173.7	(164)	2.2	---	300
AVERAGE	757.0	82	79.5	44	4016.1	(158)	---	2	309

TABLE IV

METEOROLOGICAL OBSERVATIONS ON SAIPAN

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature °F.	Daylight hours with sunshine %	Rainfall Annual Total mm. (inches)		Wind Velocity	Fair Days	Days With Rain
1927	758.3	84	77.9	58	2413.6	(95)	4.4	9	271
1928	757.7	83	77.9	55	2880.5	(113)	4.8	6	291
1929	758.3	81	77.5	58	2164.0	(85)	5.0	6	274
1930	758.5	82	77.4	58	1926.4	(76)	5.1	7	273
1931	758.9	82	78.1	61	1705.4	(67)	4.4	12	270
1932	758.5	82	78.1	61	1706.0	(67)	4.7	1	289
1933	758.4	81	78.1	62	1628.8	(64)	4.3	7	263
1934	758.3	82	78.1	61	2804.2	(110)	4.4	7	267
1935	757.7	84	77.7	57	3302.8	(130)	4.5	3	273
1936	758.3	81	77.9	59	2129.3	(84)	4.7	2	251
1937	758.8	82	77.7	62	1710.0	(67)	4.6	3	273
1938	758.4	82	77.9	59	2135.4	(84)	4.2	3	267
1939	758.4	83	78.1	57	1988.7	(78)	4.4	---	262
AVERAGE	758.3	82	77.9	59	2191.9	(86)	4.6	5	271

TABLE V

METEOROLOGICAL OBSERVATIONS ON TRUK

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature °F.	Daylight hours with sunshine %	Rainfall Annual Total mm.	(inches)	Wind Velocity	Fair Days	Days With Rain
1927	757.0	81	81.6	---	2136.7	(84)	---	---	190
1928	757.0	81	81.3	---	2140.1	(84)	---	---	218
1929	757.2	88	79.5	---	2507.4	(99)	2.2	---	271
1930	758.4	83	80.4	---	1810.1	(71)	---	---	250
1931	759.2	87	79.5	---	2843.9	(112)	2.0	---	254
1932	759.4	91	79.3	---	3692.0	(145)	1.0	---	363
1933	758.0	95	79.2	---	3779.8	(149)	1.1	---	331
1934	757.8	86	79.3	---	3575.6	(141)	1.6	---	295
1935	756.8	82	80.8	52	3587.3	(141)	2.9	---	279
1936	757.1	80	81.0	56	2773.1	(109)	3.4	2	271
1937	757.1	80	81.0	57	3165.3	(125)	3.2	2	268
1938	757.0	83	80.4	50	4184.1	(164)	3.1	1	289
1939	----	--	----	--	------	---	---	---	---
AVERAGE	757.7	85	80.2	54	3016.3	(119)	2.3	2	269

TABLE VI

METEOROLOGICAL OBSERVATIONS ON YAP

Year	Average Atmosphere Pressure mm.	Average R.H. %	Mean Temperature °F.	Daylight hours with sunshine %	Rainfall Annual Total mm.	Rainfall Annual (inches)	Wind Velocity	Fair Days	Days With Rain
1927	756.7	89	78.8	----	3527.8	(139)	---	---	265
1928	756.8	88	78.6	----	2970.2	(117)	---	---	242
1929	757.1	90	77.9	----	3241.1	(128)	---	---	288
1930	757.5	88	78.1	----	3490.6	(137)	3.0	---	256
1931	757.6	87	78.6	----	2805.3	(110)	---	---	260
1932	-----	--	----	----	------	---	---	---	---
1933	757.7	87	78.3	----	2806.8	(111)	2.6	---	215
1934	757.2	87	78.4	----	3311.0	(130)	2.8	---	219
1935	757.1	87	78.4	----	2684.7	(106)	2.4	---	181
1936	757.3	86	78.3	----	3193.6	(126)	---	---	207
1937	757.3	84	----	----	2507.6	(99)	---	---	189
1938	756.8	84	80.1	55	3277.8	(129)	2.7	---	242
1939	756.8	86	80.4	56	3154.2	(124)	3.2	---	274
AVERAGE	757.2	87	78.8	56	3080.5	(121)	---	---	237

RAINFALL FROM 1918 TO 1920 (recorded by South Sea Government)

	1918	1919	1920	Average
Saipan Is.	1,786.80 mm.	1,655.00 mm.	2,231.16 mm.	1,890.90 mm.
Koror Is. Palau Islands	3,483.70	2,471.73	2,412.68	3,122.70
Moen Is. Truk Islands	2,020.90	2,557.10	3,222.72	2,953.50
Yap Is.	2,480.00	2,410.90	3,107.04	2,665.58
Ponape Is.	4,992.30	4,251.33	3,679.20	4,307.60
Jaluit Is.	3,388.93	5,953.80	2,203.56	2,848.87

MONTHLY RAINFALL (recorded by South Sea Government, 1920)

	Saipan	Palau	Yap	Truk	Ponape	Jaluit
January	58.0 mm.	136.3 mm.	214.3 mm.	124.0 mm.	251.4 mm.	89.6 mm.
February	48.2	82.0	115.1	124.6	234.2	185.6
March	224.4	157.0	87.7	407.3	342.8	249.5
April	81.8	225.5	84.9	93.1	340.1	147.5
May	54.2	225.6	211.8	169.9	241.3	166.3
June	181.1	398.8	287.6	205.3	225.5	230.1
July	550.6	663.3	754.4	259.8	475.5	206.0
August	466.6	235.0	283.6	523.7	351.8	156.0
September	180.0	261.9	254.0	264.0	144.0	288.0
October	254.0	517.0	299.5	288.0	256.2	199.2
November	133.6	255.0	199.5	358.4	333.6	197.1
December	118.4	396.2	215.7	413.0	482.8	88.3
Monthly Average	185.93	284.39	258.92	268.56	306.60	183.63

APPENDIX B

POPULATION DATA ON MICRONESIA

These data were compiled from Japanese census reports on the Japanese Mandated Islands and the American census reports on Guam.

APPENDIX B

TABLE I

NATIVE POPULATION IN THE JAPANESE MANDATED ISLANDS ACCORDING TO DISTRICTS

	SAIPAN	YAP	PALAU	TRUK	PONAPE	JALUIT	TOTAL
1920	3398	8338	5754	14788	6638	9589	48,505
1925	3493	7366	5957	14961	7599	9422	48,798
1927	3655	7215	5733	15147	7753	7302	48,885
1928	3696	6566	5891	15172	7895	9325	48,545
1929	3790	6545	13114(?)	14969	7914	9356	48,617
1930	3829	6486	6009	15200	8201	9970	49,695
1934	4297	5968	6230	15129	8953	9963	50,540

APPENDIX B

TABLE 2

JAPANESE POPULATION IN THE JAPANESE MANDATED ISLANDS ACCORDING TO DISTRICTS

	SAIPAN	YAP	PALAU	TRUK	PONAPE	JALUIT	TOTAL
1920	1758	97	592	601	425	198	3671
1925	5299	156	1054	347	357	217	7430
1927	6023	221	1428	344	418	233	8667
1928	9326	216	1685	382	549	302	12,460
1929	12,794	245	1815	437	608	303	16,202
1930	15,656	241	2078	749	689	422	19,835
1934	39,731	368	6558	1980	2484	485	51,606

APPENDIX B

TABLE 3

FOREIGN POPULATION IN THE JAPANESE MANDATED ISLANDS ACCORDING TO DISTRICTS

	SAIPAN	YAP	PALAU	TRUK	PONAPE	JALUIT	TOTAL
1920	3	4	15	5	6	13	46
1925	8	13	19	9	12	5	66
1927	6	16	15	18	17	11	83
1928	10	10	14	20	19	8	81
1929	12	7	14	19	29	19	102
1930	11	8	14	23	20	20	96
1934	15	11	10	24	30	2	92

APPENDIX B

TABLE 4

TOTAL POPULATION IN JAPANESE MANDATED ISLANDS ACCORDING TO DISTRICTS

	SAIPAN	YAP	PALAU	TRUK	PONAPE	JALUIT	TOTAL
1920	5159	8439	6361	15,394	7069	9800	52,222
1925	8800	7535	7030	15,317	7968	9644	56,294
1927	9684	7452	7176	15,509	8188	9546	56,294
1928	13,032	6792	7590	15,574	8463	9635	61,086
1929	16,596	6799	7872	15,425	8551	9678	64,921
1930	19,496	6735	8101	15,972	8910	10,412	69,626
1934	44,043	6347	12,798	17,133	11,467	10,450	102,238

APPENDIX B

TABLE 5

POPULATION OF GUAM

1920	14,724
1925	16,648
1930	19,139
1935	20,899
1940	21,502
1941	21,994

APPENDIX C

SOURCES OF DRINKING WATER IN THE JAPANESE MANDATED ISLANDS

These data are translations of the report of Arai (1928) on the sources of drinking water in Micronesia. It is recommended that this information be used only as a source of information on the location of supplies. Information on water analyses and potability should not be accepted until verified. Supplementary information can be found in the ONI Monographs on the various Micronesian Groups and the Military Government Handbooks (OPNAV 50 E-1) for the various parts of Micronesia.

1. MARIANAS ISLANDS

(1) Saipan Is. (Examined in April, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Suspe Coast	well	turbid	salty	neutral	very much	127.0	no	no	no	medium	little	no
Charan-Kija	lake	turbid	salty	neutral	very much	886.0	no	no	trace	little	little	no
Garapan (civilian residence)	well(1)	slightly turbid	no	neutral	medium	63.0	no	no	no	medium	no	Yes, when filtered and boiled
Garapan (civilian residence)	well(2)	slightly turbid	salty	neutral	much	170.0	no	no	no	medium	no	no
Garapan (civilian residence) Sadokutashii	well(3)	slightly turbid	salty	neutral	much	137.0	no	no	no	medium	little	no
Asumaitok	river	slightly turbid	salty	neutral	medium	145.0	no	very little	trace	medium	very little	no
Cable Station	spring	clear	no	neutral	very little	145.0	no	no	no	medium	no	yes
Tanabaku	running	slightly turbid	no	neutral	medium	21.5	no	no	no	medium	very little	Yes, when filtered
Saipan Hospital	rain	clear	no	neutral	very little	5.0	no	no	no	no	no	Yes
Saipan Government	rain	clear	no	neutral	(not tested)	4.0	no	no	no	no	no	Yes

(1) Saipan Is. (Examined in April, 1925) (Contd)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Kalapera	river	turbid	no	neutral	very little	35.5	no	no	no	medium	medium	yes, when filtered
Donnay	river	clear	no	neutral	very little	51.0	no	no	no	medium	medium	yes

(2) Tinian Island. (Examined in April, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Marupo	well	turbid	salty (weak)	neutral	much	177.5	no	no	no	much	medium	no
Sonson	well	clear	salty (weak)	neutral	much	173.8	no	no	no	much	little	no
Chyuru Lake	marsh	turbid	salty (weak)	neutral	much	251.8	no	no	trace	much	much	no

(3) Rota Island. (Examined by the Saipan Hospital)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Tenito Coast	well	clear	no	neutral	-	414.5	no	no	no	30.0	-	no
Tetoge Coast	well	slightly turbid	slightly salty	neutral	-	175.0	"	"	"	26.0	-	no
Afuefunia	river	slightly turbid	no	neutral	-	317.6	"	"	"	11.7	-	yes, when filtered
Rupo	spring	clear	no	neutral	-	185.1	"	"	"	15.4	-	yes
Rupo	river	"	"	neutral	-	185.5	"	"	"	10.2	-	"

2. MARSHALL ISLANDS

(1) Jaluit Is.

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Obin minister	well	clear	no	neutral	little	75.0	not found	no	no	little	little	yes
Kafui	well	clear with floating substance	salty	neutral	much	over 150.0	not found	no	no	little	much	no
Yaboru	well	clear with floating substance	salty	neutral	little	over 150.0	not found	no	no	little	much	no
Yaruto Public School	rain	clear	no	neutral	very little	25.0	no	no	no	no	little	yes
Bansufuhiritsupu Co.	rain	clear	no	neutral	very little	20.0	no	no	no	no	little	yes

(2) Wottho Is. (Examined in July 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cable Station Telegram Bur.	rain	clear	no	neutral	very little	17.0	not found	no	no	not found	not found	yes
Official Residence	well	"	"	"	little	65.0	"	"	"	medium	"	yes, when boiled
Aibutsushiyu	well	"	weakly salty	"	"	72.0	"	"	"	"	"	yes, when boiled
Beside native church	well	"	no	"	"	60.0	"	"	"	"	"	yes, when boiled
Sobida	well	"	no	"	"	54.0	"	"	"	"	trace	yes, when boiled
Rujin	well	"	salty	"	"	155.0	"	"	"	"	little	no
Rui Pond	pond	colorless, slightly turbid	"	"	medium	250.0	"	"	trace	little	much	"

(3) Maloelab Is. (Examined in July, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cistern of South Sea Trade Co.	rain	clear	no	neutral	not found	12.0	medium	no	no	not found	not found	yes
Village elder residence	well	clear with floating substance	"	"	much	48.0	"	"	"	little	very little	no
Native Church	well	"	"	"	much	40.0	"	"	"	"	"	no
In front of Public School	well	"	"	"	"	52.0	"	"	"	"	"	yes, when filtered

(4) Eniwetok Is. (Examined in July, 1925)
(listed under East Carolines in Japanese text)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Kitsumura Residence	well	clear	salty	neutral	much	100.0	not found	no	no	medium	much	no
Bogain	"	clear with floating substance	"	"	"	over 200.0	"		"	not found	"	"
Rushiya	"	light yellowish with floating substance	"	"	"	over 200.0	"		"	little	medium	"

3. WEST CAROLINE ISLANDS

(1) Marakaru Is. (Examined in May, 1925)

(This island not shown on monograph)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Marakaru	running	clear	no	neutral	little	10 mg.	no	no	no	not detected	not detected	yes

(2) Koror Island. (Examined in May, 1925)
(Shown in monograph as one of the
Palau Islands)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
South Sea Government	rain	clear	no	neutral	very little	8.0	not found	no	no	not found	not found	yes
Palau Hospital	"	"	"	"	very little	8.0	"	"	"	not found	"	"
Palau Telegraph Office	well	"	"	weak acid	little	20.0	"	"	"	not found	"	"
Arabaketsu Market	well	clear but with floating subs.	slight odor	neutral	very little	26.0	"	"	"	little	"	"
Arabaketsu-Ketsuteru	well	clear	no	"	medium	21.0	"	"	"	not found	"	"
Koror-Atsuto	well	clear with floating substance	muddy smell	"	medium	30.0	"	"	"	medium	"	"
Koror-Akosoru	well	?	muddy smell	"	medium	28.0	"	"	"	medium	"	"
Koror Village elder residence	"	?	slight odor	"	little	25.0	"	"	"	little	"	"
Ueda Laundry	spring	clear	no	weak acid	very little	15.0	"	"	"	not found	"	"
Oshima Barber Shop	spring	clear	no	neutral	very little	13.0	"	"	"	not found	much	"

(3) Arakabesan Island. (Examined in June, 1925)
(Shown in monograph as one of the Palau Islands)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Basasu	spring	clear	no	neutral	very little	15.0	no	no	no	not found	not found	yes
Aidarau	river	clear	refreshing	"	very little	12.0	"	"	"	not found	"	yes
Gukan	river	"	"	"	very little	12.0	"	"	"	not found	"	yes
Yōboku	"	"	"	"	very little	14.0	"	"	"	not found	"	yes
Garakison	"	"	"	"	very little	19.0	"	"	"	not found	"	yes

(4) Palau (Pelew) Islands. (Examined in June, 1925)

(Shown in monograph as a separate group)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Airai Atsukigu Village (Airai Village)	river	clear with floating substance	no	weak acid	not found	10.0	no	not found	no	not found	medium	yes, when filtered
Airai Atsukigu Village	river	clear with floating substance	no	neutral	not found	11.0	no	not found	no	not found	medium	yes, when filtered
Airai Atsukigu Village	river	clear with floating substance	no	neutral	not found	13.0	a little	not found	no	not found	not found	yes, when filtered
Marukigu Public School*	well	clear with floating substance	no	weak alkaline	little	little	no	little	no	medium	little	yes

*Examined by Palau Hospital

(5) Angaur Island

(Shown in monograph as one of the Palau Islands)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cistern in the mining office	rain	clear	no	neutral	very little	10.0	no	no	no	not found	no	yes
Public school	rain	clear	no	neutral	not found	8.0	"	"	"	not found	very little	"
Angaur hospital	rain	clear	no	neutral	not found	11.0	"	"	"	not found	no	"
Japanese Club	rain	clear	no	neutral	very little	9.0	"	"	"	not found	very little	"
Village Center	well	clear	slightly salty	neutral	little	200.0	"	"	"	medium	very little	no
Laundry	well	clear	slightly salty	neutral	medium	207.0	"	"	"	medium	very little	"
Ibai Coast	well	clear	slightly salty	neutral	much	200.0	"	"	"	medium	very little	"

(6) Yap Islands. (Examined in June, 1925)

(Shown in monograph as one of the Western Carolines)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cistern in the old hospital	rain	clear	no	neutral	not found	9.0	no	no	no	no	not found	yes
Cistern on Taran Is.	rain	clear	no	neutral	not found	10.0	"	"	"	"	"	yes
Cistern in the Yap Government	rain	clear	no	neutral	not found	8.0	"	"	"	"	"	yes
A	running	clear with small amt. floating substance	no	neutral	much	40.0	"	"	"	little	much	no
B	running	clear with small amt. floating substance	no	neutral	much	30.0	"	"	"	not found	little	yes, when filtered

(7) Woleai (Oleai) Islands. (Examined in May, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Oleai Branch of South Sea Trade Co.	rain	clear	no	neutral	trace	12.0	no	no	no	no	no	yes
Used by Oleai natives	pond A	"	"	"	medium	40.0	little	no	no	little	much	yes, when boiled
Used by Oleai natives	pond B	"	"	"	much	88.0	no	no	no	medium	little	yes, when filtered and boiled

(8) Ulithi (Mackenzie) Island. (Examined in June, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cistern of Asor South Sea Trade Co.	rain	clear	no	neutral	medium	15.0	no	no	no	no	no	yes
Asor	pond	clear with a little floating substance	no	neutral	much	300.0	not found	not found	little	medium	little	no
Asor	well	light yellowish brown	no	neutral	much	300.0	"	no	no	little	little	no
Fuararatsupu	pond (drinking water for the natives)	clear with floating substance	"	"	medium	200.0	"	"	"	"	medium	no
Fuararatsupu	(bathing water)	clear with floating substance	salty	"	much	500.0	very little	"	no	medium	much	no

(9) Ngulu Island. (Examined in May, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Ngulu	rain	clear	no	neutral	very little	13.0	no	no	no	no	no	yes
Ngulu native drinking water	pond	"	slightly smelly	neutral	much	over 400.0	medium	"	medium	medium	medium	no
Ngulu	new well	"	salty	"	much	over 700.0	much	"	trace	little	much	"

(10) Ifalik Island. (Examined in May, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Ifalik	Central Public Pond	clear	no	neutral	much	150.0	little	no	no	little	medium	no

(11) Lamotrek Island. (Examined in September, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
South Sea Trade Co. Branch	rain	clear	no	neutral	very little	15.0	no	no	no	not found	not found	yes
South Sea Trade Co. Branch	well	"	"	"	medium	50.0	"	"	"	medium	medium	yes, when boiled
Northern Central Rariratsupu	well	light yellowish	slightly smelly	"	much	45.0	medium	"	"	"	"	no
Southern Central Raremore	well	clear	no	"	much	45.0	no	"	"	medium	medium	no

(12) Fais Island. (No data)

4. EAST CAROLINE ISLANDS

(1) Truk Islands (Examined in August, 1925)

(a) Dublon Is.

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Cistern in Truk Government	rain	clear	no	neutral	no	7.0	little	no	no	Not found	Not found	yes
Cistern in Truk Post Office	rain	clear	no	neutral	no	70.0	"	"	"	not found	not found	"
Cistern in Truk Hospital	rain	clear	no	neutral	no	70.0	"	"	"	not found	not found	"
In front of Club	well	clear	no	neutral	medium	18.0	"	"	"	not found	medium	"
Shimura, on Dublon Is.	well	clear with floating substance	no	neutral	medium	25.0	"	"	"	not found	medium	yes, when filtered
Cistern of South Sea Trade Co.	rain	clear	no	neutral	not found	8.0	medium	"	"	not found	medium	yes
Water tank of South Sea Trade Co.	running	clear with floating substance	no	weak acid	not found	15.0	very little	"	"	medium	not found	yes, when filtered
Navy water tub	river	clear with floating substance	no	neutral	not found	15.0	little	"	"	not found	not found	yes, when filtered
Rara mura	river	clear with float. subs.	no	neutral	very little	17.0	little	"	"	medium	not found	yes, when filtered
Manchu Park of Nechiyapu	river	clear	no	neutral	not found	16.0	little	"	"	little	not found	yes

(1) Truk Islands

(b) Moen Is.

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Manmura Ratsuketo	well	clear	salty	neutral	no	140.0	no	no	no	medium	medium	no
Manmura Baodē	well	clear	no	neutral	very little	20.0	no	no	no	medium	little	yes
Man Branch of South Sea Trade Co.	well	clear	no	neutral	not found	30.0	no	no	no	not found	not found	"
Manmura Mairo Chief	well	clear	no	neutral	very little	33.0	no	no	no	medium	medium	"
New well at the of Mairo Chief (1)	well	clear	no	neutral	much	35.0	no	no	no	medium	very little	yes, when filtered and boiled
New Well at the of Mairo Chief (2)	well	clear	no	neutral	much	33.0	no	no	no	medium	"	yes, when filtered and boiled
Airiya River	running	clear with floating substance	no	neutral	very little	30.0	no	no	no	medium	little	yes, when filtered

(1) Truk Islands

(c) Uman Island.

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Mozon-Mura, Uriboshi	A running	clear	no	neutral	medium	27.0	not found	no	no	not found	not found	yes
Mozon-Mura, Uriboshi	B running	clear	no	neutral	medium	20.0	"	"	"	not found	not found	"
Mozon-Mura, Uriboshi	pond	with whitish floating subs.	no	neutral	much	40.0	very little	"	"	medium	medium	yes, when boiled and filtered
Mozon-Mura, Bida	rain	clear	no	neutral	very little	12.0	not found	"	"	not found	not found	yes

(1) Truk Islands

(d) Fefan Is.

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Mesamura Aura River	river	clear with a little whitish color	no	neutral	medium	34.0	little	no	no	little	medium	yes, when filtered
Mesamura Nukurefuain Public Well	well	clear with a little whitish color	no	neutral	medium	50.0	little	no	no	medium	little	yes, when filtered and boiled
Mesa-Mura Elder Residence	well	clear with floating substance	no	neutral	medium	56.0	little	no	no	medium	little	yes, when filtered and boiled

(1) Truk Islands

(The islands listed below are a group of the Truk Is.)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Monday Is., Fuanazau	running	clear with floating substance	no	neutral	medium	17.0	not found	no	no	not found	not found	yes, when filtered
Friday Is., Nebii-Mura	running	clear with floating substance	no	neutral	medium	22.0	not found	no	no	not found	not found	yes, when filtered
Wednesday Is., Public School	"	clear with floating substance	no	neutral	medium	10.0	not found	no	no	not found	not found	yes, when filtered
Wednesday Is., Osukusuri	river	not clear with floating substance	no	neutral	much	16.0	not found	no	no	not found	not found	no
Wednesday Is., Ruru River	"	slightly turbid with floating substance	no	neutral	medium	18.0	not found	no	no	not found	not found	yes, when filtered
Wednesday Is. Nechyachya River	well	clear	no	neutral	medium	54.0	very little	no	no	little	not found	yes, when boiled

(2) Oroluk Is. (Examined in September, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Oroluk Branch of South Sea Trade Co.	rain	clear	no	neutral	no	15.0	no	no	no	no	little	yes
Oroluk Branch of South Sea Trade Co.	well	clear	salty	neutral	much	93.0	no	no	no	medium	"	no
Center of Oroluk Is. (used by natives)	pond	slightly yellowish with floating sub.	salty & with slight odor	neutral	much	150.0	no	no	no	very little	medium	no
Pond in the center of Biheraru Is.	pond	clear with yellowish color	like fallen leaves	weak alkaline	much	38.0	no	no	very little	little	no	no

(3) Ponape Is. (Examined in June, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Shokage Is.	running	clear	no	neutral	very little	10.0	not found	no	no	not found	not found	yes
Mokuban River	river	clear	no	neutral	very little	14.0	not found	"	"	not found	not found	"
Koroni Water Tub	running	clear	no	neutral	very little	13.0	not found	"	"	not found	not found	"
Fudo River Swimming Pool	river	clear	no	weak acid	very little	8.0	not found	"	"	not found	not found	"
Chusen	river	clear	no	neutral	very little	6.0	not found	"	"	not found	not found	"
Upper Asama Bridge	river	clear	no	neutral	very little	9.0	not found	"	"	not found	not found	"
Koroni Public School	well	clear	no	neutral	very little	8.0	not found	"	"	not found	not found	"
Yanchin (opposite Yoroni)	running	clear	no	neutral	very little	7.0	not found	"	"	not found	not found	"
Ranka official residence	rain	clear	no	neutral	very little	5.0	not found	"	"	not found	not found	"

(3) Ponape Island. (Examined in March, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Kiu-Mura, Ronkichi Public School	mountain stream	clear	no	neutral	very little	very little	-	no	no	trace	-	yes, when boiled
Kiu-Mura, Ronkichi	mountain stream	clear	no	neutral	very little	very little	-	no	no	"	-	yes, when boiled
Kiu-Mura, Ronkichi Nankomaru	mountain stream	clear	no	neutral	very little	very little	-	no	no	"	-	yes, when boiled
Kiu-Mura, Ronkichi Public School	rain	clear	no	neutral	very little	very little	-	no	no	not found	-	yes
Metarammu-Mura Public School	well	clear	no	neutral	very little	very little	-	no	no	no	-	yes, when boiled

(4) Kusaie Is. (Examined in July, 1925)

Locality	Kinds of Water	Appearance	Odor & Taste	Reaction	Organic Matter	Chloride	Nitrate	Nitrite	Ammonia	Lime	Sulphate	Potability
Rere Is., Northern Coast of Metain	spring	clear	no	neutral	very little	15.0	very little	no	no	not found	medium	yes
Innemu River	river	clear	no	neutral	not found	12.0	very little	no	no	not found	not found	yes, when filtered
Opposite Rere Is. Matairitsuku	stream	clear	no	neutral	little	18.0	very little	no	no	not found	not found	yes, when filtered
Tafueyatsuto (opposite Rere Is.)	stream	clear	no	neutral	not found	11.0	not found	no	no	not found	not found	yes, when filtered
Sanshiku	stream	clear with floating substance	no	neutral	little	12.0	not found	no	no	not found	not found	yes, when filtered
Maregu River	river	clear	no	neutral	much	13.0	not found	no	no	not found	not found	yes, when filtered and boiled